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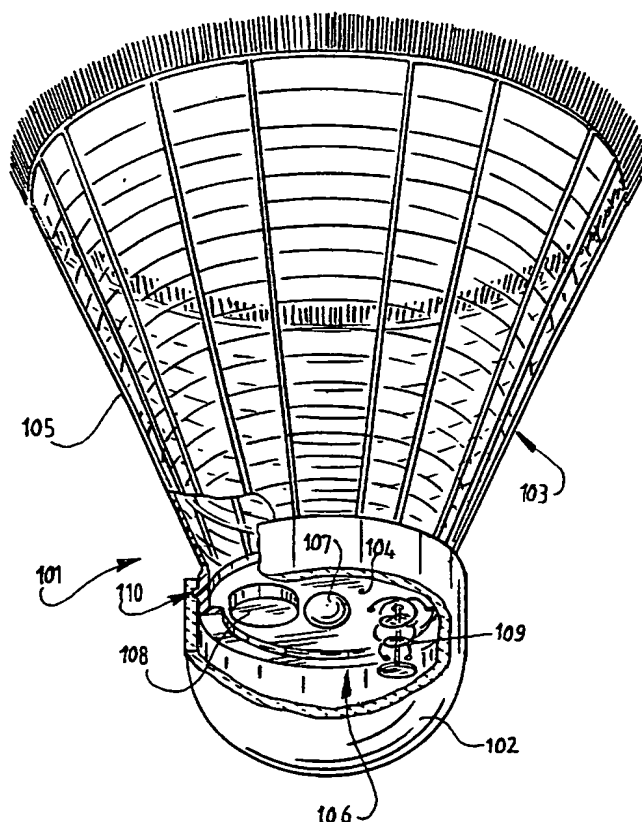
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(54) Title: DEVICE FOR POSITIONING AND LIFTING A MARINE STRUCTURE, PARTICULARLY A PLATFORM DECK



(57) Abstract: A device for positioning and lifting a marine structure, particularly a platform deck, with the use of a U-shaped lifting vessel (1). The device has at least two adjustable lifting frames (12, 12), each able to incline towards the middle of the docking area. Each of the lifting frames (12) consists of an upper horizontal lifting beam (13), preferably situated on a level above the top of the lifting vessel (1). The near-vertical part of the lifting frame (16) is connected to the lifting beam (13) in the upper end and in the lower end hinged (21) to the lifting vessel (1). The near-horizontal part of the lifting frame (18) is in one end connected to the lifting beam (13) and in the other end adjustably connected to the lifting vessel (1).



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Device for positioning and lifting a marine structure, particularly a platform deck.

The present invention is related to a device for positioning and lifting a marine structure, particularly a platform deck, with the help of a lifting vessel.

In connection with offshore activities such as gas and oil exploitation it is usual to install platforms on the field. These platforms often consist of large and heavy platform substructures fixed to the seabed. Such a platform substructure is normally a so-called "jacket", which is a steel truss structure. On top of for example a jacket it is usual to place a platform deck, which is used in connection with drilling and production. The deck also often includes living quarters.

To transport and install the jacket and the platform deck described above, for example barges have been used to transport the jacket and platform deck out to the field, and large crane vessels have been used to install the platform on the field.

Heavy lift vessels using ballast to vary their draft have also been used to transport and install platforms offshore.

There are today a great number of offshore platforms installed to exploit oil and gas. When the oil and/or gas reservoirs are fully exploited the life span of the platform is usually over and it would in most cases be appropriate to remove the platform.

Some platforms are already removed, and removal of platforms will continue at an increasing pace the coming years.

The traditional way of removing platforms is to use large ocean going lifting cranes. The platform needs to be very thoroughly prepared prior to removal, and it must be cut into smaller parts since even the largest lifting crane vessels have limited lifting capacity. The same goes for the platform substructure (the jacket).

These operations are time consuming and costly, not only because the lifting cranes are large, expensive and need a large crew, but also because cutting a

platform to smaller pieces in open sea is a very complicated task. It is also a risky operation.

The new technology, as described in this application, can be described as "single lift technology", and will reduce the costs considerably. It will also make the operations less risky than present alternatives. Within the category "single lift technology" there are three other concepts that the applicant is aware of at the moment:

"Offshore Shuttle" is a vessel planned built as a frame work structure. The vessel has a significant length and the lifting of for example a platform deck is based on crossbeams spanning across the structure.

"Master Marine" is developing a U-shaped semi submersible with deck-structure connecting the top of columns. Lifting is based on load transfer to the deck-structure.

"Versatruss" is a concept involving two separate barges each supporting its own lifting frame. By pulling the barges together after positioning the lifting frames beneath the lifting points on the platform deck, the lifting of the deck can be performed. This method has already been used to remove small platform decks in calm waters.

One object of the present invention is to accomplish a removal operation of a platform in a fast and cost effective manner without cutting either the deck or the jacket into smaller parts. The removal operation shall be performed in a safe way where the safety of the operators is accomplished in the best possible way.

Another object of the present invention is that the lifting and handling equipment is as flexible as possible and that it can be easily adjusted to fit different sized platform decks. Further the equipment shall be able to lift and handle jackets of different sizes. In accordance with the invention the device is intended to be used together with a vessel, a so-called Multi Purpose Unit, MPU, which also can transport e.g. the platform deck to shore, and then transfer the deck to a barge or a pier suitable to the vessel.

Another object of the device is that it also shall be able to be used for installation of platforms, which basically is the reverse of removal. The device should furthermore be applicable for a range of purposes where a large lifting capacity is required.

The objects described above is achieved according to the invention by a device for positioning and lifting a marine structure, particularly a platform deck, within the docking area of a lifting vessel recognised by having at least two adjustable lifting frames, each able to incline towards the middle of the docking area. Each of the lifting frames consists of an upper horizontal lifting beam, preferably situated on a level above the top of the lifting vessel. The near-vertical part of the lifting frame is connected to the lifting beam in the upper end and in the lower end hinged to the lifting vessel. The near-horizontal part of the lifting frame is in one end connected to the lifting beam and in the other end connected to the lifting vessel by a guide rail and an adjustable lock bolt.

Preferred embodiments of the device is described in the claims 2 to 9.

The present invention is described below by means of embodiments and with references to the figures, where:

Fig. 1a shows a lifting vessel employed together with the device according to the present invention,

Fig. 1b shows the lifting vessel according to the present invention,

Fig. 2 shows the lifting vessel positioned around a jacket with a platform deck,

Fig. 3 shows a steel tubular rotation beam for lifting and rotating a jacket structure,

Fig. 4 shows a device for lifting and rotating a jacket structure for installation or removal,

Fig. 5a–5c show the vessel in connection with lifting and rotating a jacket structure where a special “cradle” is used,

Fig. 6 shows the device of the present invention in the form of lifting frames for lifting of preferably a platform deck,

Fig. 7 shows hydraulic jacks for operating the lifting frame, situated between the lifting vessel and the inclined legs of the lifting frame and the figure also shows the steel tubular beam for lifting and rotation/removal of a jacket structure,

Fig. 8 shows a hydraulic lock bolt system for locking of the lifting frame in a certain position to a guide rail connected to the lifting vessel,

5 Fig. 9 shows one first alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck,

Fig. 10a and 10b show a second alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck,

10 Fig. 11a and 11b show a third alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck,

Fig. 12, 13, 14 and 15 show step by step the operation sequence for removal of a platform deck with the help of the lifting vessel, and

15 Fig. 16, 17, 18, 19 and 20 show step by step the operation sequence for removal of a jacket structure with the help of the lifting vessel.

20 The device according to the present invention will now be described with reference to the figures, especially fig. 1a and 2.

25 The device according to the present invention will now be described in connection with a lifting vessel protected through the Norwegian patent application no. 99 2759 held by the applicant of the present invention. The device according to the present invention is therefore described in connection with this lifting vessel, however it shall be noted that the device can be applied with other vessels and other equipment.

30 The lifting vessel 1 (MPU) is developed as a floating concrete hull with a U-shaped pontoon foundation 2 containing two longitudinal pontoons 2a, 2b and a transverse pontoon 2c, and with columns 5 through the water surface for hydrostatic stability and optimal behaviour in the sea. The columns 5 are not connected structurally at the top, which is made possible by a rigid and robust hull structure. A brim 3 along the lower edge of the pontoon foundation improves further the behaviour of the vessel in the sea. The vessel 1 is
35 specially developed for operations offshore. The U-shape of the pontoon foundation 2a, 2b, 2c enables the vessel to position itself around a platform being installed or a platform being removed, be it the platform deck or a platform substructure. The lifting operation is performed according to Archimedes' principle by ballasting/deballasting the vessel 1. The lifting is
40 mainly performed vertically, but the vessel 1 can be inclined in all directions to enable special lifting operations.

Positioning of the vessel 1 is considered done by tugs, but thrusters can be installed to make the vessel 1 self-propulsive. The vessel 1 is designed to operate in all oceans in all parts of the world. The vessel 1 is also designed to be transported on a heavy lift ship to ease transportation over large distances.

The vessel 1 is equipped with devices specially fitted for the operations the vessel 1 is intended for. Installation and removal of platforms (platform decks and platform substructures) for the oil and gas industry are examples of operations the vessel 1 is intended for.

Installation and removal of platform substructures are mentioned above as fields of operation for the vessel 1. The vessel 1 will now be described in relation to these operations, especially in connection with the handling of jackets. Steel jackets are widely used all over the world in the oil and gas industry as substructure for offshore oil and gas production units. There are also many other situations where a jacket structure is suitable as a support structure. There will be a market for both installation and removal of jackets in the future. Below is described operations concerning removal of a jacket. For installation the operations will be performed in the reverse order.

Lifting brackets 25 are attached to the jacket legs on one side of the jacket at a certain, pre-established height. A circular tubular rotation beam 22 is fixed to the top of the transverse pontoon 2c of the lifting vessel 1. The lifting vessel 1 is positioned around the jacket with the help of tugs and active use of a device according to the present invention, a lifting frame 12. This device will be described more thoroughly later in connection with lifting devices for positioning and lifting of a platform deck. The vessel 1 is hauled to a position where the transverse pontoon 2c of the vessel 1 is positioned close to the side of the jacket where the lifting brackets 25 are attached. The lifting vessel is ballasted to the desired draft and inclination of heel so that the tubular rotation beam 22 connects with the lifting brackets 25, see fig. 4, concurrent with the lower edge of the transverse pontoon 2c bear against the jacket legs with fenders between them. The lifting brackets 25 are locked to the tubular rotation beam 22 and by deballasting the lifting vessel 1 the jacket is lifted. When the jacket is lifted clear of the seabed or foundation the lower part is lifted to the surface using wires and winches (or buoyancy modules), thereby rotating the jacket about the tubular rotation beam 22, before transportation to a new destination.

The lifting brackets 25 are made of steel of robust design and will absorb all forces introduced by the lifting and rotating operations. The lifting brackets 25 are designed to lock onto the tubular rotation beam. The lifting brackets 25 easily rotate on the tubular rotation beam 22.

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Pre-engineering is required with regards to the strength of the jacket structure before a lift can take place. The jacket legs must be reinforced if they cannot endure the loads introduced. The lifting brackets 25 can, if necessary, be shaped with two long tubular clamps with a plate between them, so that they can be mounted to the main leg and a diagonal bracing of the jacket. The brackets 25 will then absorb the forces from the tubular rotation beam 22 and distribute them to the tubular clamps, which in turn distribute the forces onward in axial direction of the legs and the braces of the jacket, and so avoiding the largest shear forces. This device must be dimensioned for each individual case.

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For some jackets it may be difficult to dimension the support for the brackets 25. If this is a problem a "lifting cradle" according to the invention can be used, see fig. 5. The lifting cradle is attached to the tubular rotation beam 22 and uses this as a rotation point as described above. The cradle 29 is a framework consisting of two triangular frames pointing outwards with a pointed end upwards, attached to the tubular rotation beam 22 on the pontoon. The triangular frames are connected with a tubular beam at the bottom of the perpendicular. The cradle 29 consists of tubes 2-3 meters in diameter that are filled with water when the cradle 29 is in its lowest position and will be emptied when the lift starts. The large dimensions secure structural strength and enough buoyancy to contribute to the lift.

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The lifting vessel 1 is positioned as described above and the cradle 29 will embrace the jacket. Specially adjusted saddles are attached to the lower circular beam on the cradle 29, resting against the jacket legs. To avoid the jacket from sliding off the cradle 29 during the lift the jacket is connected to the tubular rotation beam 22 through brackets attached to the jacket legs. On the back of the lifting vessel 1 winches are mounted on each side of the "docking area" i.e. the inner area of the U-shaped pontoon foundation surrounded by the two longitudinal pontoons 2a, 2b and the transversal pontoon 2c. Winches onboard tugs can also be used. Through pulleys wires with a hook in one end is hooked to the lower corners of the cradle 29. The cradle 29 is now lifted upwards rotating about the tubular rotation beam 22 and the jacket is lifted out of the water for safe transportation to shore. An alternative method is to ballast/deballast the vessel 1 combined with the use of buoyancy modules attached to the jacket.

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The present device for positioning and lifting of a platform deck will now be described with reference to the drawings. Platform decks exist in different sizes and to be able to handle them all, the lifting device must be large,
5 strong and flexible/adjustable, with strict requirements to the shape for positioning around the substructure carrying the deck.

Lifting frame 12 according to a design of the present invention is fitted with a horizontal robust lifting beam 13 at the top and is pin-connected 21 to the
10 top of the longitudinal pontoons 2a, 2b on each side of the docking area, see fig. 1. The lifting frame 12 consists of a near-horizontal structure 18, preferably a truss structure, going from the horizontal lifting beam 13 to the upper anchorage point 10 on the lifting vessel 1. Furthermore the lifting frame 12 consists of a vertical support structure 16, preferably a truss-work, connected in its upper end to the lifting beam 13 and connected in its lower end
15 to the lifting vessel through an anchorage point 11, preferably a pin connection 21. The lifting frames 12, 12 in the upright position stands taller than the top of the lifting vessel 1, such that the lifting beams 13, 13 are always above the hull of the lifting vessel 1. The lifting frames 12, 12 can, with the
20 use of the hydraulic cylinders 20, 20 connected to the lifting vessel 1 and the lifting frames 12, 12, see fig. 1a and 7, be inclined towards the middle of the docking area to position the lifting beams 13, 13 under the lifting points on the platform deck. The two lifting frames 12, 12 can be run independently. The lifting frames 12, 12 are locked in the right position before the lift
25 starts, with hydraulic bolts 9 through holes 8 in guide rails 7 connected to each of the four columns 5 on the hull of the lifting vessel 1, see fig. 1a and 8. This ensures fixation in all directions included sea fastening during transport. Plane outer walls 6 tangentially fixed to the columns 5 are supporting the guide rails 7. The plane walls 6 are furthermore perpendicular to the
30 direction of the connection line between two columns 5,5.

The connection between the lifting beam 13 and the deck can be carried out in different ways. Below is described three ways that ensures adequate flexibility to absorb shocks during a lift off:

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- i) The lifting beam 13 can be equipped with a shock absorbing cover 14 while also placing shock absorbing cushions underneath the deck. If it is not possible to lift directly underneath the deck the upper part of the jacket can be fitted with brackets 26 with shock cushions so that the
40 lifting beam 13 can get a proper hold, see fig. 9. Prior to lift off the jacket will be cut right below the brackets 26.

- ii) Hydraulic cylinders 30 are placed on top of the lifting beam 13 in well calculated positions to get direct contact with the lifting points on the deck structure (or brackets 26 on the upper part of the jacket). Shock absorbing cushions are placed between the deck structure and the hydraulic cylinders 30 to obtain maximum damping, see fig. 10.
- iii) "Shock cells" consisting of cylinders 35 filled with sand or another shock absorbing material is placed on top of the lifting beams 13 in well calculated positions. Conical tube stubs 37 are placed in corresponding positions on the deck structure. The conical tube stubs 37 absorb shocks when they penetrate the sand-filled cylinders 35, see fig. 11a. An alternative is that both the tube stubs 37 and the shock cells 35 are mounted on the deck structure, see fig. 11b.
- The MPU 1 is positioned around a jacket structure with deck and is made ready for lift off and removal of the deck. The lifting frames 12, 12 on each side of the docking area is actively used for positioning by inclining them against the jacket with the help of hydraulically controlled arms 20, see fig. 2. Additionally the positioning is done by tugs. The lifting frames 12, 12 are pulled back into lifting position when the MPU 1 is in the right position, as described above. The MPU 1 is then deballasted slowly until the lifting beams 13 are touching the lifting points. Compensation for the vertical motions of the MPU 1 is partly done by flexible shock cushions mounted on the lifting beams and lifting points, and partly by the use of a flushing system that ensures a quick load transfer. When the deck has a safe clearance to the jacket the MPU is pulled away from the jacket before ballasted down to transport draft.

The flushing system consists of flushing (ballast) tanks 4 above the water-line with large area quick release trapdoors that enable the water to flush out. Trapdoors on different levels enable multiphase flushing, i.e. flushing in several steps.

This example describes the operations for removal of a platform deck. The different operations are illustrated in a sequence of figures; fig. 12-15:

- i) Positioning around a jacket with a deck.
With the help of tugs the MPU 1 is positioned around the jacket. The lifting frames 12, 12 are in upright position with good clearance to the jacket. The draft of the vessel 1 ensures good clearance to the deck, see fig. 12.

- ii) Using the lifting frames 12, 12 to fine adjust the position around the jacket.

When the MPU 1 is approaching the correct position the lifting frames 12, 12 are inclined against the jacket to dampen the horizontal motions of the MPU 1 and also to fine-adjust the position. This is done by active use of hydraulics, see fig. 13.

- iii) Deballasting the MPU 1, ready for lift-off.

The MPU 1 is deballasted while the lifting frames 12, 12 glide along the jacket structure to dampen the horizontal motions. The deballasting proceeds until the lifting frames 12, 12 are right under the lifting points on the deck. The lifting frames 12, 12 are then locked into position and MPU 1 is ready for lifting off the platform deck, see fig. 14.

- iv) Lift-off of the deck

When the MPU 1 is ready to lift off the deck, water in the flushing tanks 4 are let out quickly by opening the quick release trapdoors in the columns 5 thereby achieving a rapid lift. The deck is prepared in advance by cutting the connections between the deck and the jacket, see fig. 15.

- v) Ready for transportation to shore

After lift-off the MPU 1 is pulled away from the remaining jacket. The MPU 1 is deballasted down to transportation draft when it is clear from the jacket. If necessary additional sea fastening to the locking of the lifting frames 12, 12 are added and the transportation to shore can start. It is also possible to transfer the deck to a barge for transportation to shore so that the MPU 1 is immediately available for new operations (e.g. removal of the jacket).

This example describes the operations for removal of a jacket structure. The different operations are illustrated in a sequence of figures; fig. 16-20:

- vi) Positioning around a jacket (without a deck).

With help from tugs the MPU 1 is positioned around the jacket. The lifting frames 12, 12 are in upright position with good clearance to the jacket, see fig. 16.

- vii) Using the lifting frames 12, 12 to fine adjust the position around the jacket.

When the MPU 1 is approaching the correct position the lifting frames 12, 12 are inclined against the jacket to dampen the horizontal motions of the MPU 1 and also to fine-adjust the position. This is done by active use of hydraulics, see fig. 17.

- viii) The MPU is inclined and deballasted, ready for lift-off

The MPU 1 is inclined and deballasted until the tubular rotation beam 22, situated on top of the transversal pontoon 2c, gets a hold of the brackets 25 pre-installed on the jacket, see fig. 18.

ix) Lift-off

5 When the MPU 1 is ready to lift off the jacket, water in the flushing tanks 4 are let out quickly by opening the quick release trapdoors in the columns 5 thereby achieving a rapid lift. The jacket is prepared in advance by cutting the jacket legs, piles, risers etc., see fig. 19.

x) Tilting of the jacket, ready for transportation

10 After lift-off, the jacket is rotated to a near-horizontal position with the use of winches and wires mounted on the aft of the MPU 1 or winches and wires onboard tugs, see fig. 20. An alternative method is to attach buoyancy modules to the jacket. After sea fastening the transportation to shore can start. An alternative is to transfer the jacket
15 to a barge for transportation to shore so that the MPU 1 is immediately available for new operations.

PATENT CLAIMS

- 5 1. A device for positioning and lifting a marine structure, particularly a platform deck, with the use of a U-shaped lifting vessel (1), characterised by having at least two adjustable lifting frames (12,12), each able to incline towards the middle of the docking area. Each of the lifting frames (12) consists of an upper horizontal lifting
10 beam (13), preferably situated on a level above the top of the lifting vessel (1). The near-vertical part of the lifting frame (16) is connected to the lifting beam (13) in the upper end and in the lower end hinged (21) to the lifting vessel (1). The near-horizontal part of the lifting frame (18) is in one end connected to the lifting beam (13) and in the
15 other end adjustably connected to the lifting vessel (1).
2. A device according to claim 1,
characterised by a shock absorbing cover (14) on the horizon-
tal lifting beam (13).
- 20 3. A device according to claim 2,
characterised by the shock absorbing cover (14) is made of rubber.
- 25 4. A device according to claim 1,
characterised by the lifting beam (13) is equipped with hydraulic cylinders (30) in pre-defined lifting point positions.
- 30 5. A device according to claim 1,
characterised by the lifting beam (13) is equipped with sand-filled cylinders (35) in pre-defined lifting point positions since the sand-filled cylinders (35) are corresponding with the belonging conical tubular stubs (37) attached on the platform deck.
- 35 6. A device according to all of the above claims,
characterised by the lifting frame (16) is a truss structure.
7. A device according to all of the above claims,
characterised by the near-horizontal structure (18) is a truss
40 structure.
8. A device according to all of the above claims,

characterised by the near-horizontal structures (18) having adjustable connection points to the lifting vessel (1) consisting of a hydraulically operated bolt (9) going into a corresponding hole (8) in a guiding rail (7) attached to the lifting vessel (1).

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9. A device according to all of the above claims, characterised by the lifting frames (16) in an area above the jointed bearing (21) are equipped with adjustable hydraulic arms (20) connected to the lifting vessel (1).

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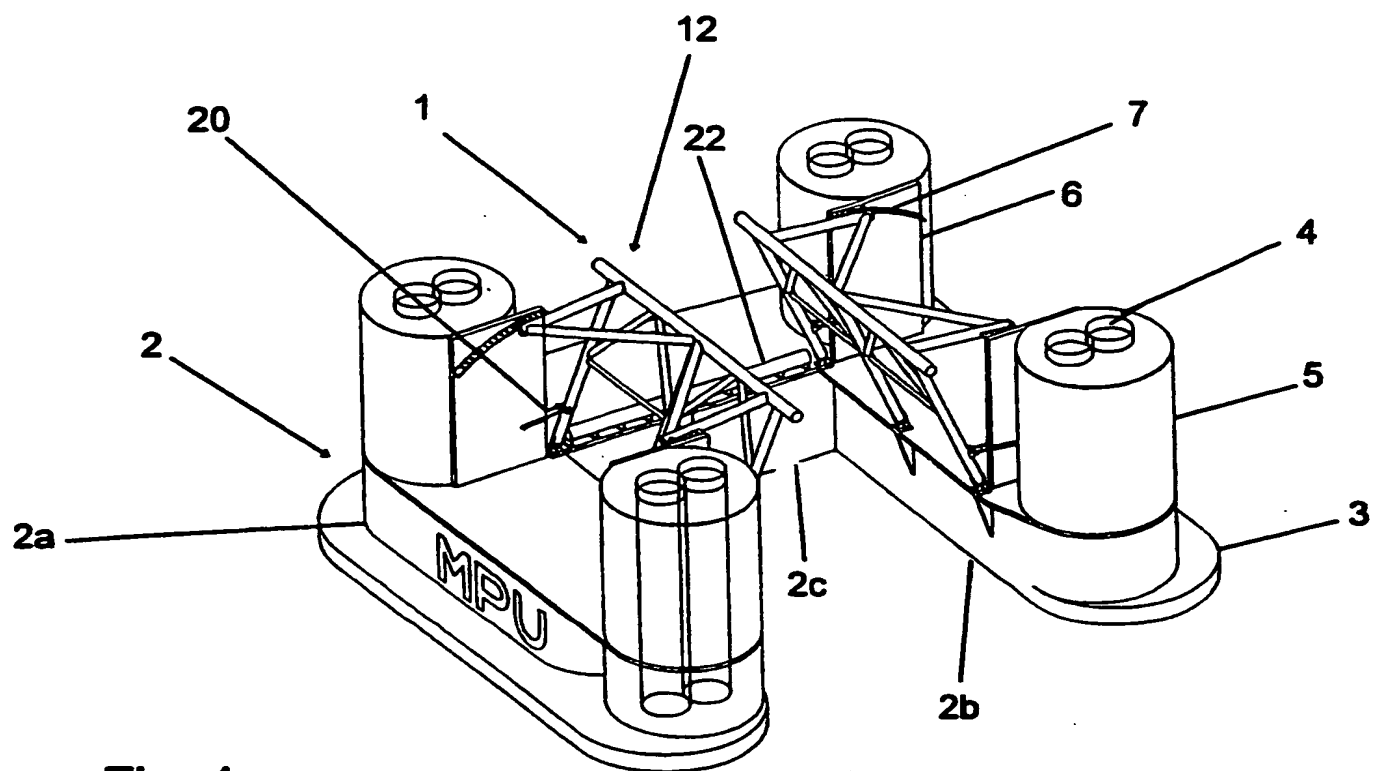


Fig. 1a

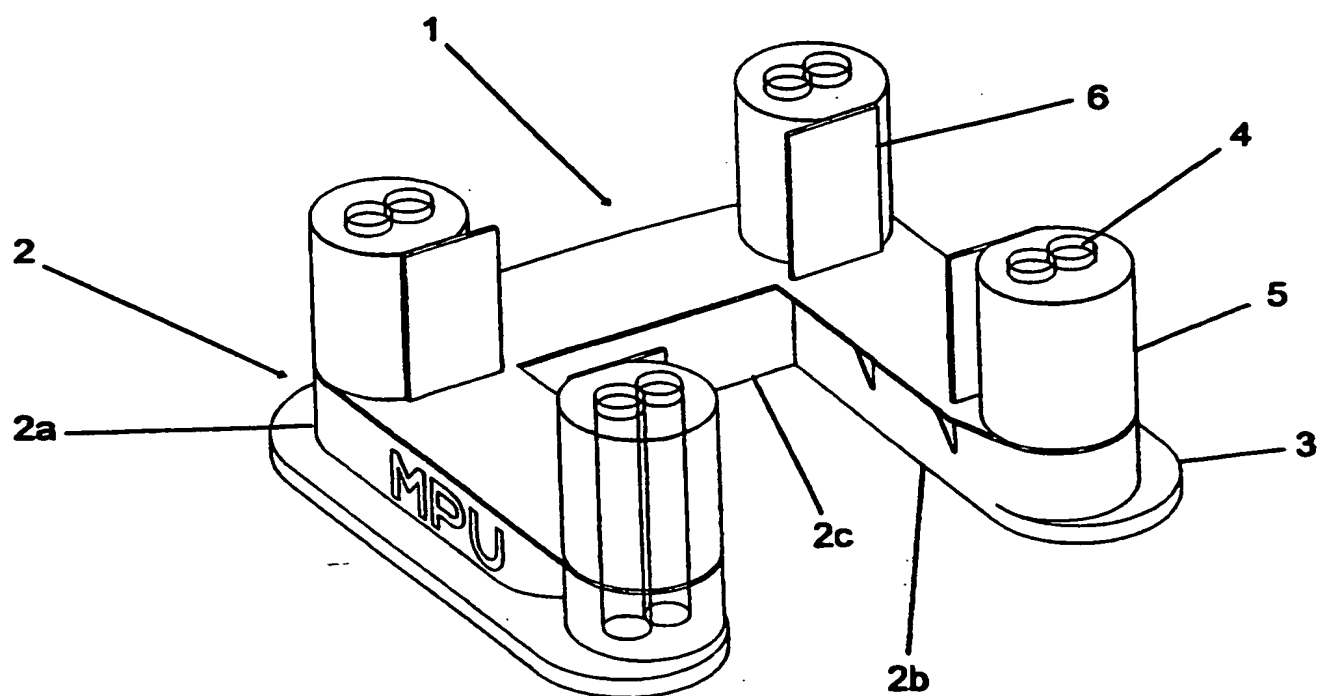


Fig. 1b

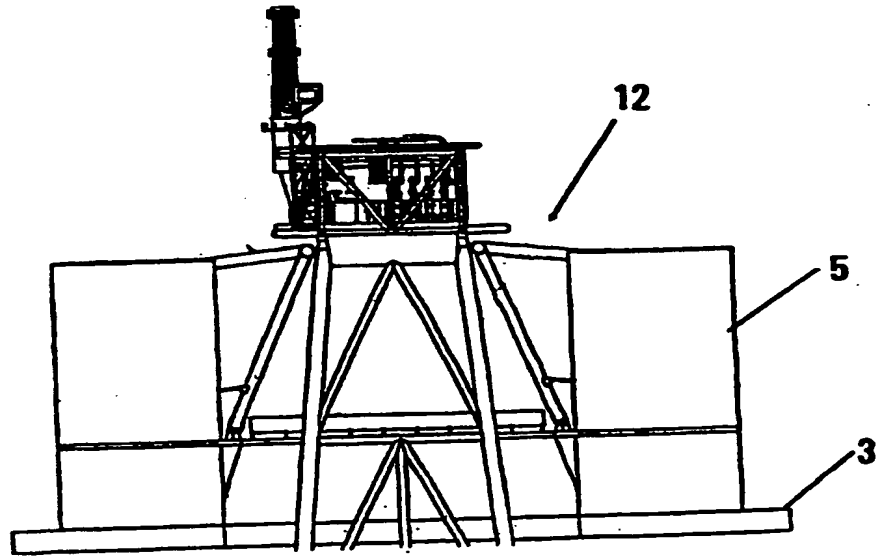


Fig. 2

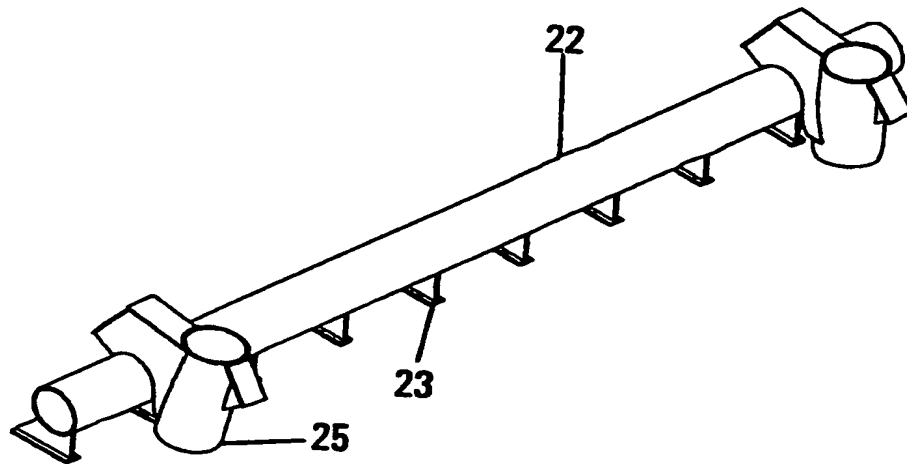


Fig. 3

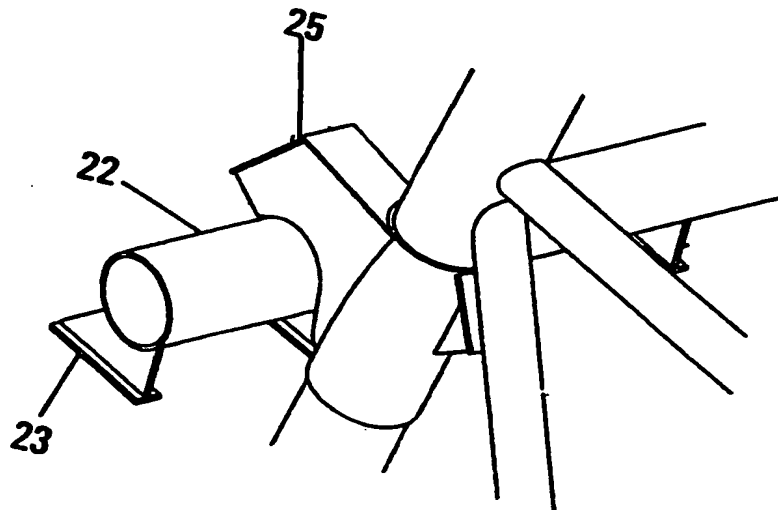
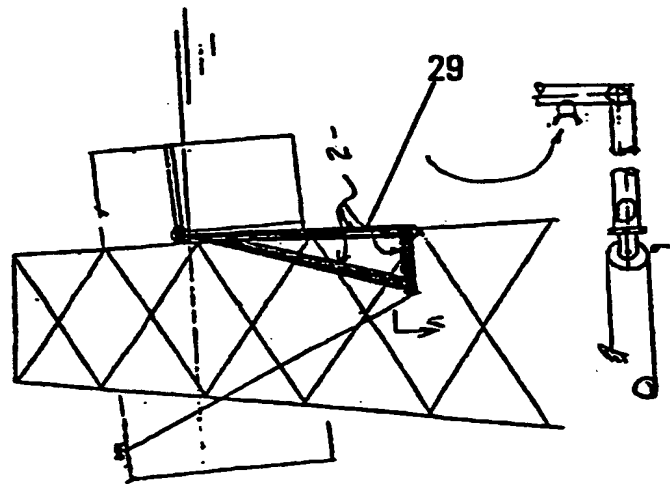
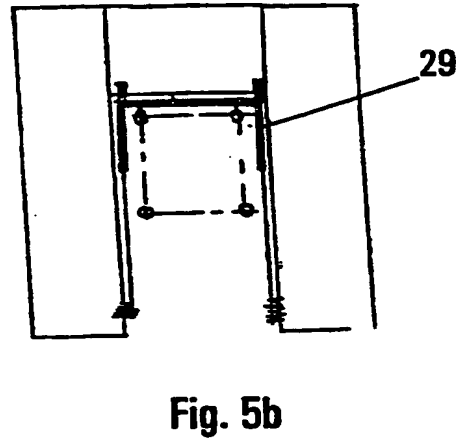
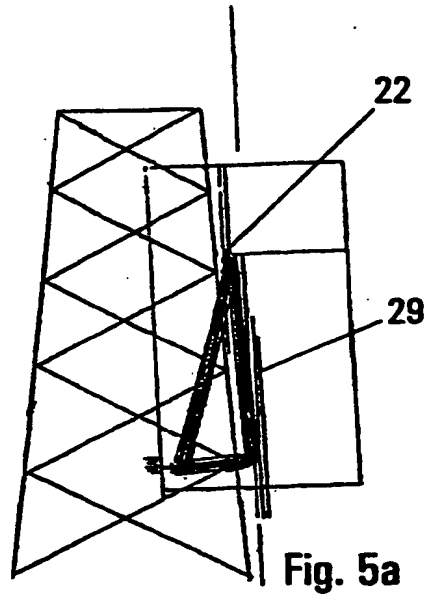


Fig. 4

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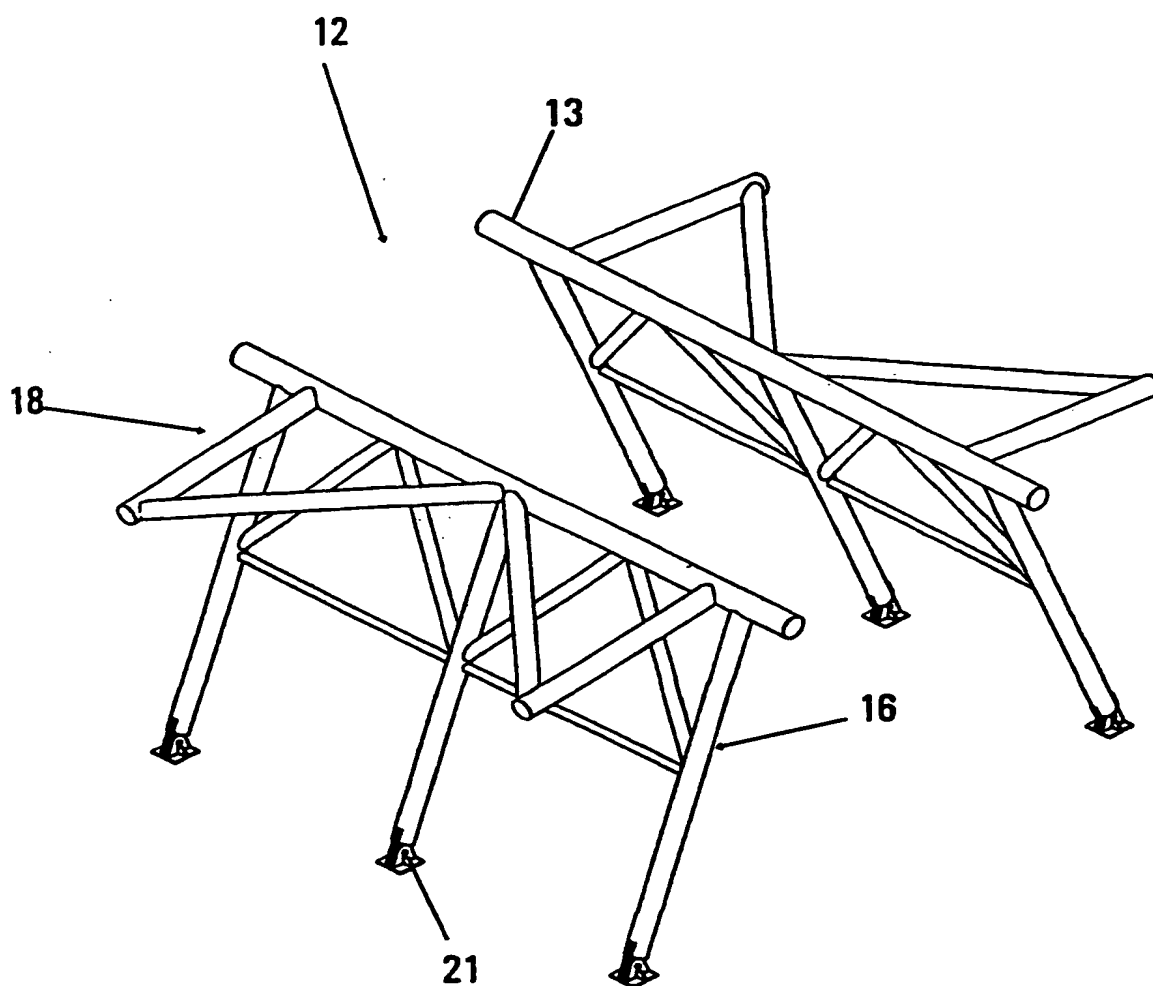


Fig. 6

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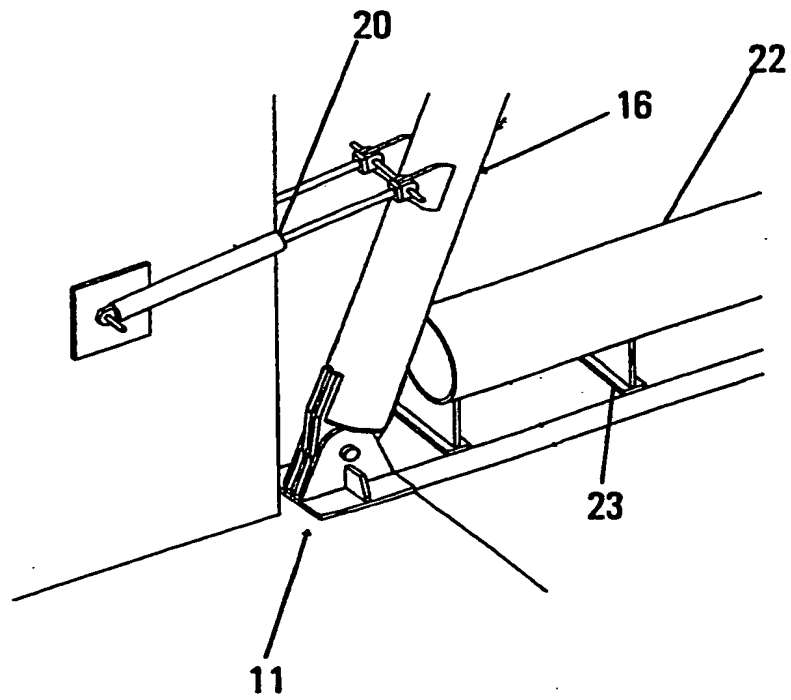


Fig. 7

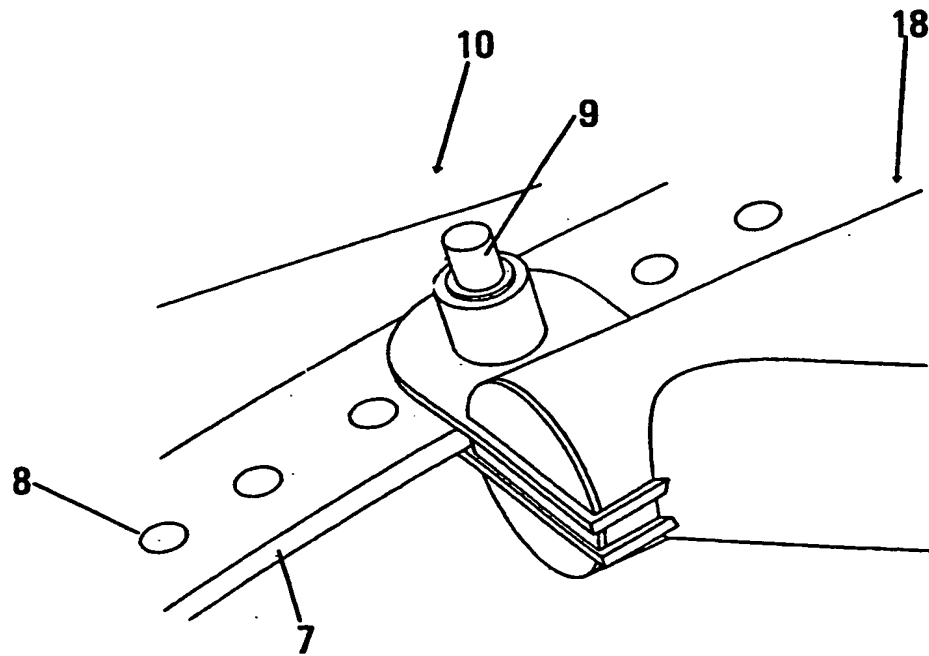


Fig. 8

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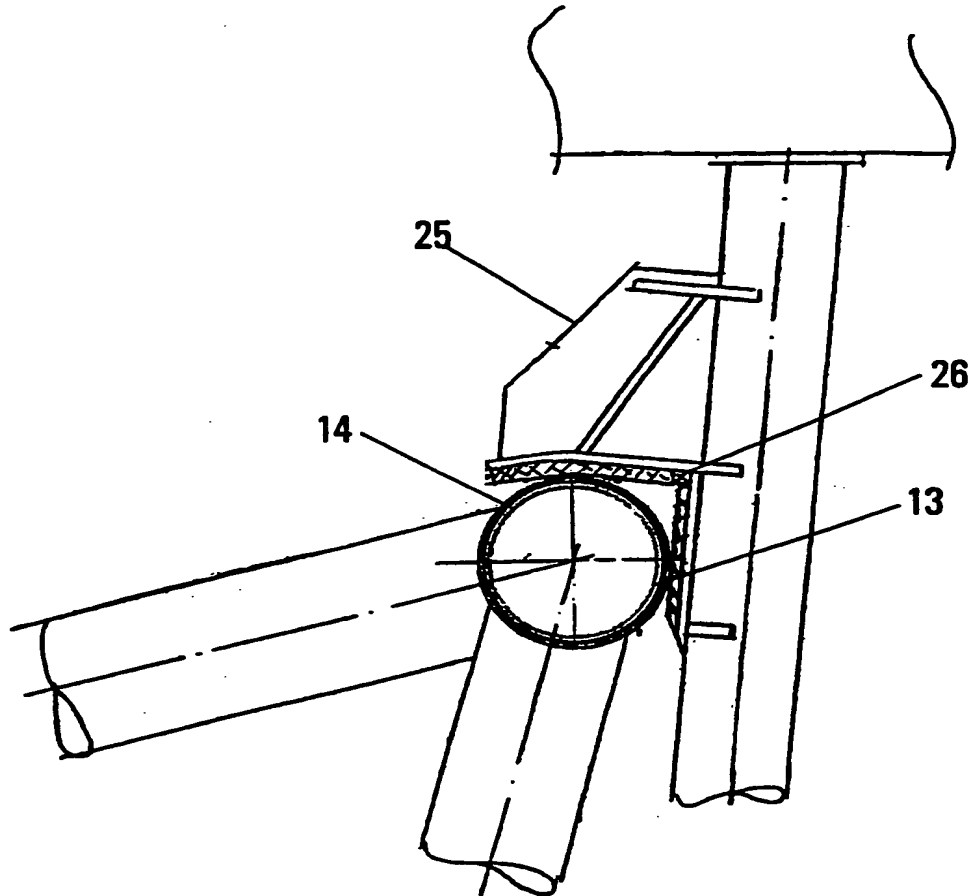


Fig. 9

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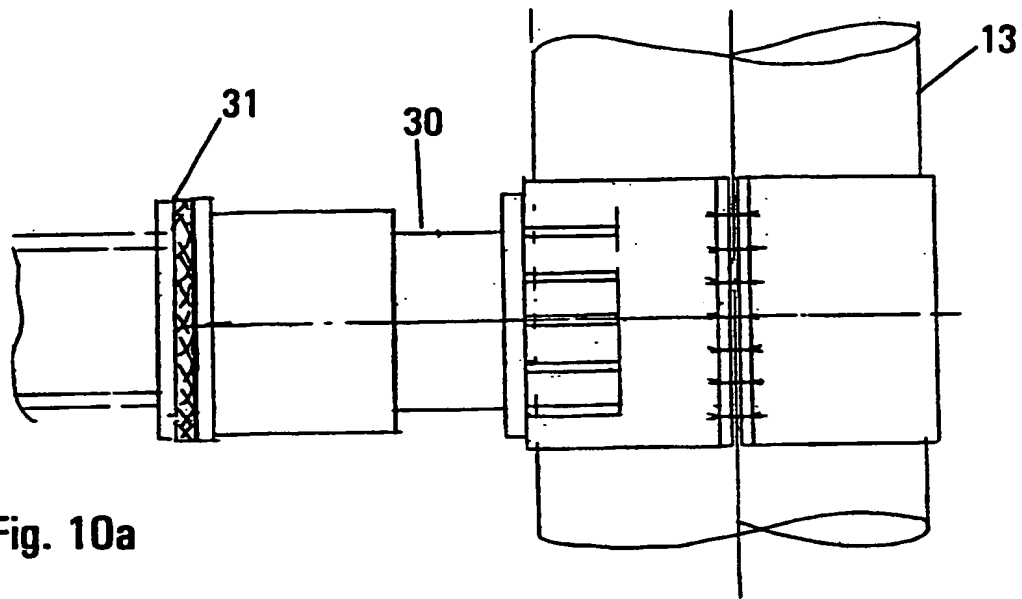


Fig. 10a

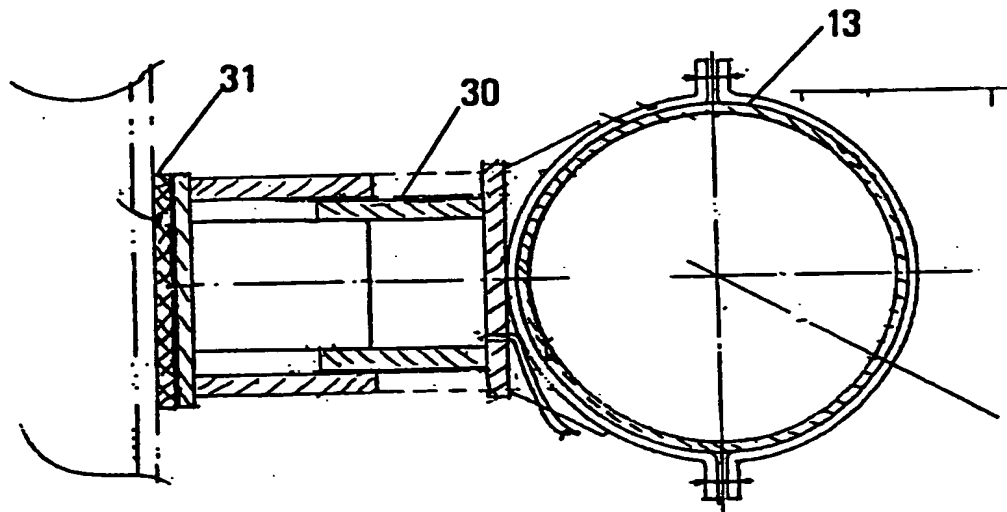


Fig. 10b

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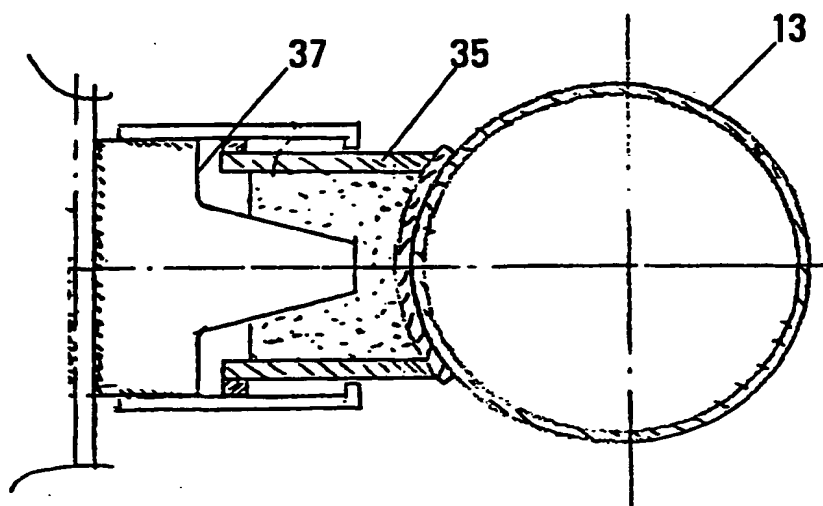


Fig. 11a

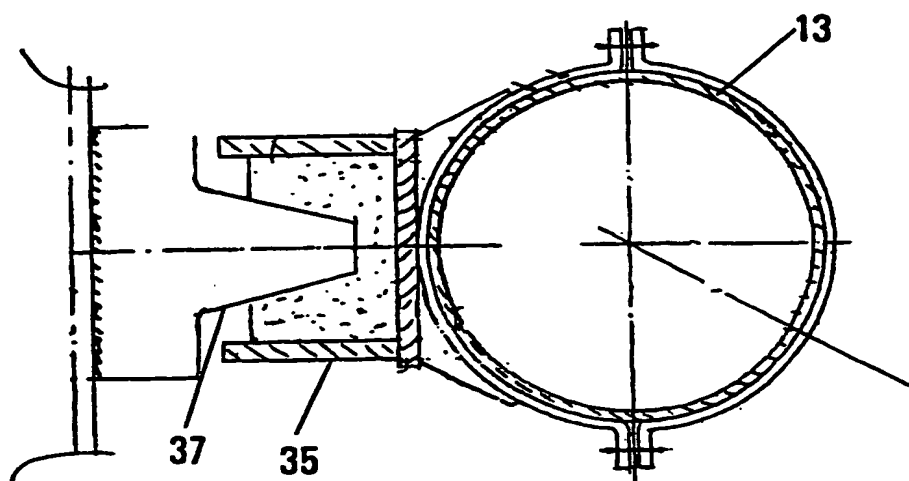
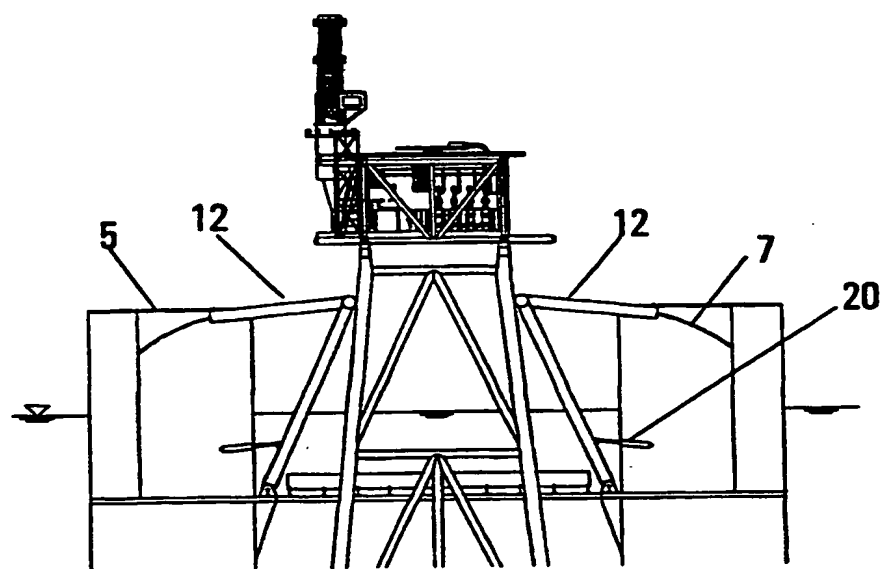
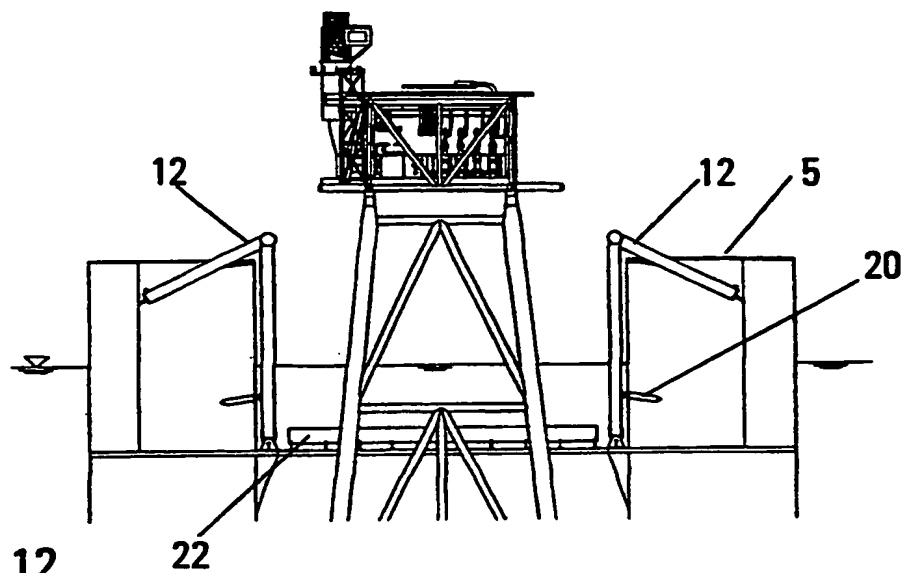


Fig. 11b

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10/13

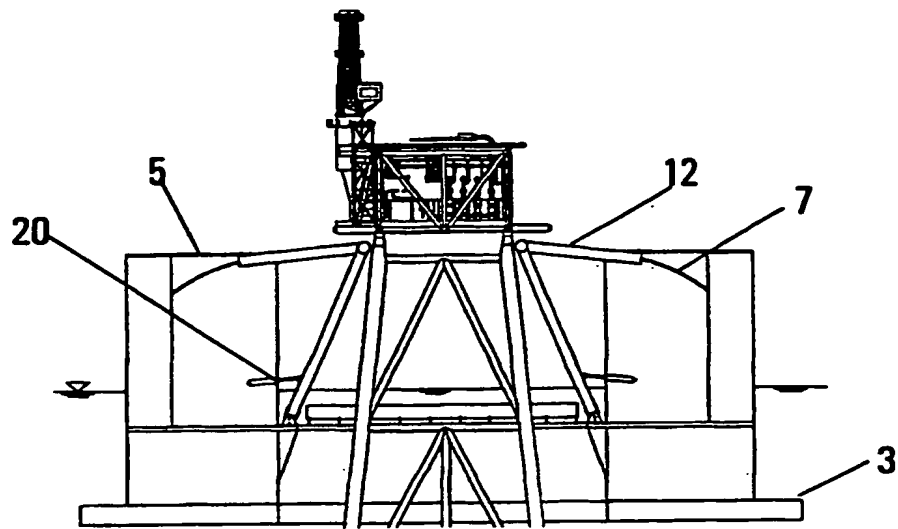


Fig. 14

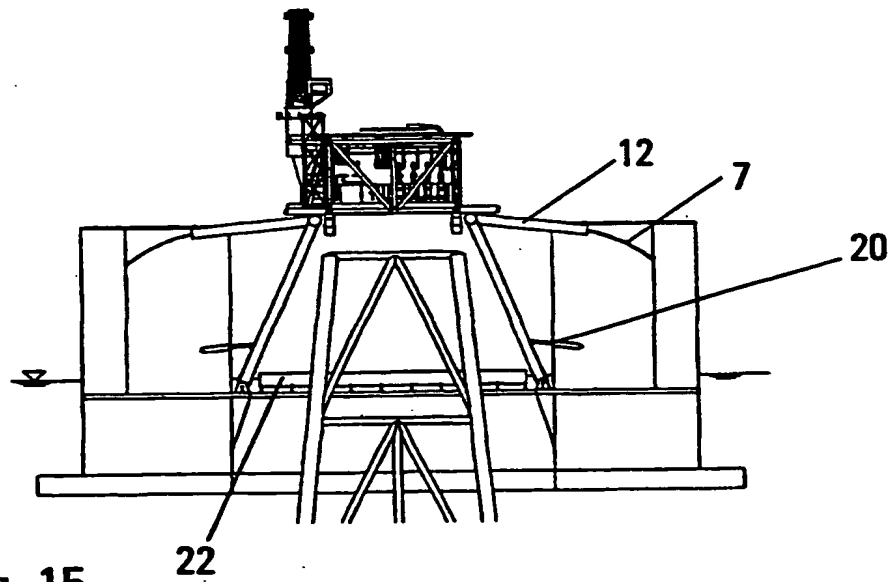


Fig. 15

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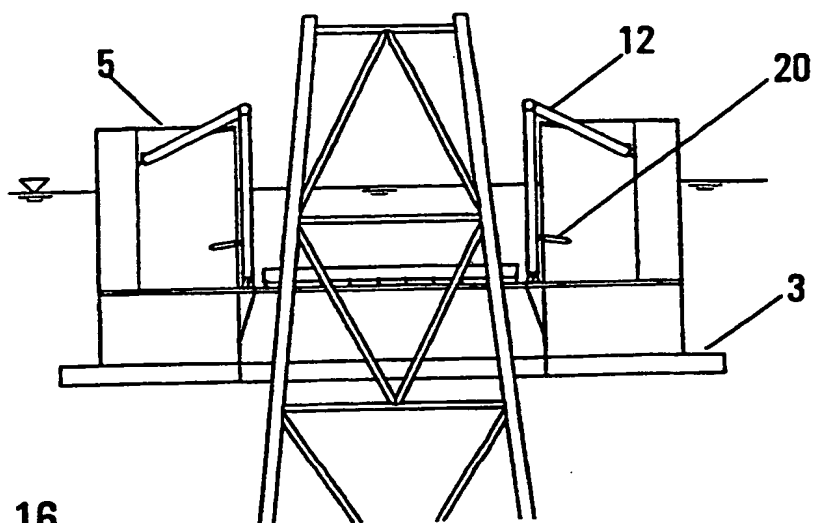


Fig. 16

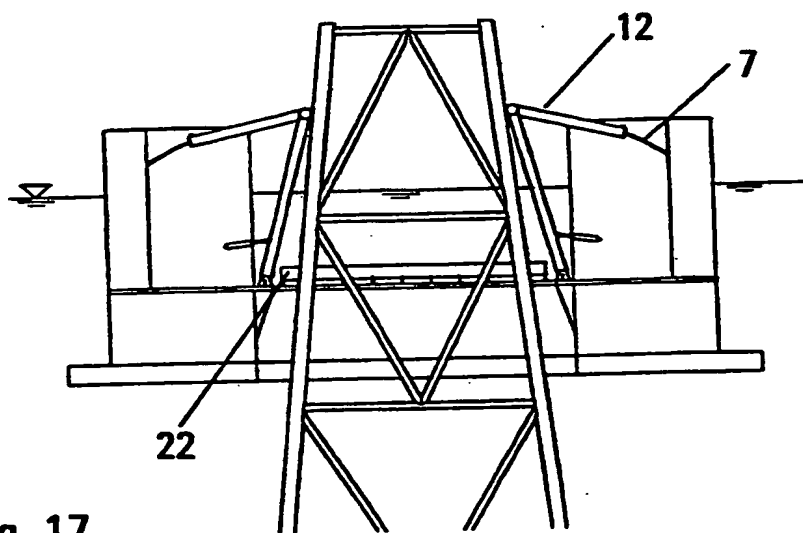


Fig. 17

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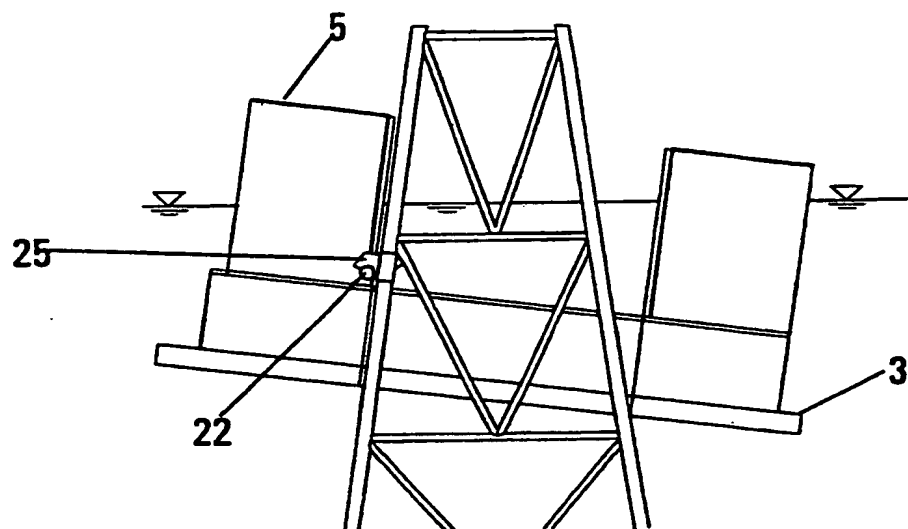


Fig. 18

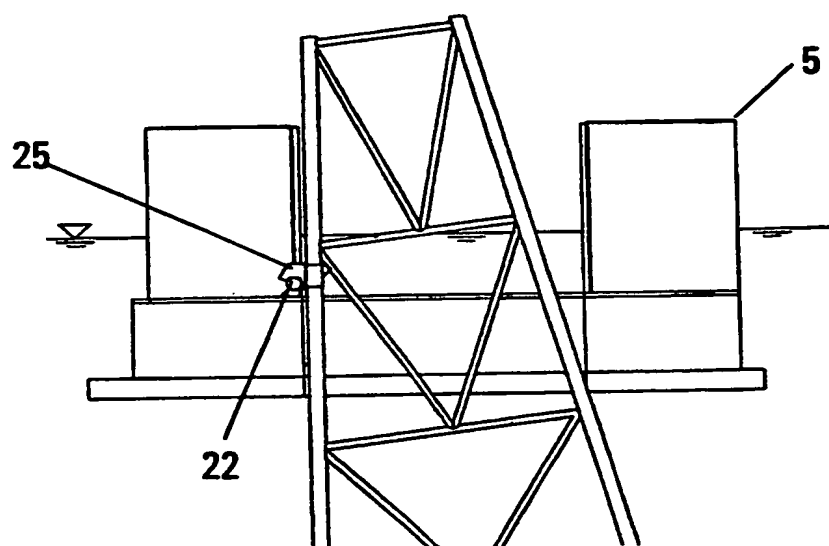


Fig. 19

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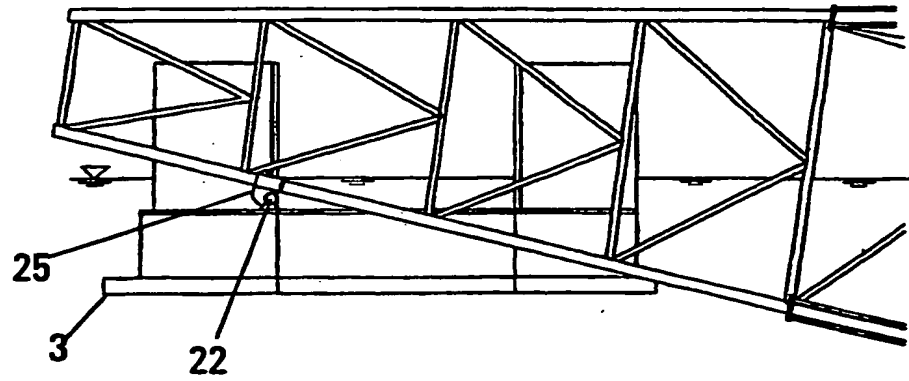


Fig. 20

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 00/00198

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B63B 35/44, E02B 17/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B63B, E02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5829919 A (HEEREMA), 3 November 1998 (03.11.98) --	1-9
A	US 4714382 A (KHACHATURIAN), 22 December 1987 (22.12.87) --	1-9
A	US 4744697 A (COPPENS), 17 May 1988 (17.05.88) -- -----	1-9

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

- * Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

13 October 2000

Date of mailing of the international search report

18-10-2000

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INTERNATIONAL SEARCH REPORT
Information on patent family members

01/08/00

International application No.

PCT/NO 00/00198

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
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				BE	1009792 A	05/08/97
				BR	9605399 A	28/07/98
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				GB	9622645 D	00/00/00
				NL	1001778 C	00/00/00
				NO	964624 A	05/05/97
				SG	65624 A	22/06/99

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				GB	8610370 D	00/00/00
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				NO	861688 A	30/10/86
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				GB	8514180 D	00/00/00

PATENT COOPERATION TREATY

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To: **BHYN & AARFLOI AS**
P.O. Box 449 Sentrum
N-0104 Oslo
NORVÈGE

Date of mailing (day/month/year)
14 December 2000 (14.12.00)

Applicant's or agent's file reference
102779/SAO

IMPORTANT NOTICE

International application No.
PCT/NO00/00198

International filing date (day/month/year)
07 June 2000 (07.06.00)

Priority date (day/month/year)
07 June 1999 (07.06.99)

Applicant
MPU ENTERPRISE AS et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
AG,AU,DZ,KP,KR,MZ,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time.

AE,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CN,CR,CU,CZ,DE,DK,DM,EA,EE,EP,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW
The communication will be made to these Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 14 December 2000 (14.12.00) under No. WO 00/75010

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent international preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

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BRYN & AARFLOT AS

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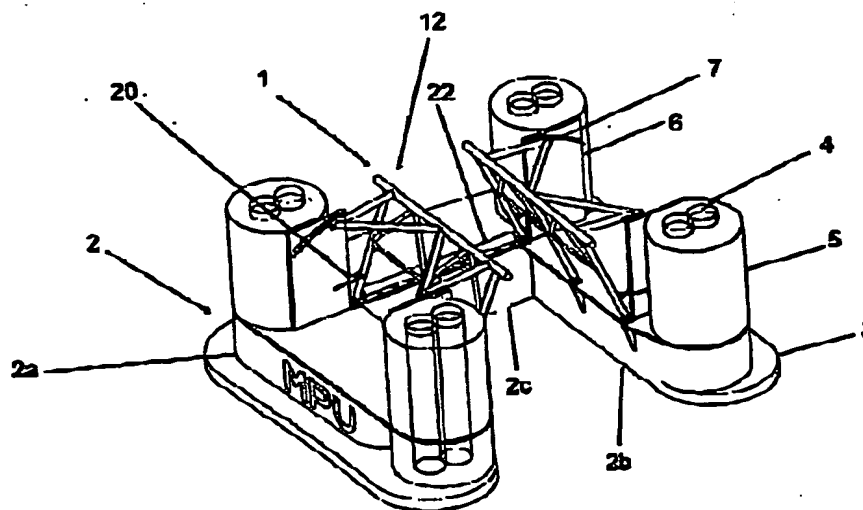
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WO 00/75010 A1(51) International Patent Classification: **B63B 35/44**,
E02B 17/02(21) International Application Number: **PCT/NOR/00198**(22) International Filing Date: **7 June 2000 (07.06.2000)**(25) Filing Language: **Norwegian**(26) Publication Language: **English**(30) Priority Data: **19992761** **7 June 1999 (07.06.1999)** **NO**(71) Applicant (for all designated States except US): **MPU ENTERPRISE AS** (NO/NO); P.O. Box 17, N-1324 Lysaker (NO).

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OLSEN, Tor, Ole (NO/NO); Dicksvei 10, N-1325 Lysaker (NO). **HÖYLAND, Kolbjörn** (NO/NO); Hasansvingen 29, N 1349 Rykkian (NO). **HÆREID, Kåre, O.** (NO/NO); Bestumvn. 75a, N-0283 Oslo (NO). **HANSEN, Jørn, Bartholm** (NO/NO); Kalkfjellst 45, N-1387 Asker (NO). **LANDBØ, Trond** (NO/NO); Vestivn. ZUB, N-1344 Hæstun (NO).

(74) Agent: **BRYN & AARFLOT AS**; P.O. Box 449 Sentrum, N-0104 Oslo (NO).(81) Designated States (national): **AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.**(84) Designated States (regional): **ARIPO** patent (GI, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW). **Eurasian** patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM). **European***[Continued on next page]*(54) Title: **DEVICE FOR POSITIONING AND LIFTING A MARINE STRUCTURE, PARTICULARLY A PLATFORM DECK**

(57) Abstract: A device for positioning and lifting a marine structure, particularly a platform deck, with the use of a U-shaped lifting vessel (1). The device has at least two adjustable lifting frames (12, 12), each able to incline towards the middle of the docking area. Each of the lifting frames (12) consists of an upper horizontal lifting beam (13), preferably situated on a level above the top of the lifting vessel (1). The near vertical part of the lifting frame (16) is connected to the lifting beam (13) in the upper end and in the lower end hinged (21) to the lifting vessel (1). The near-horizontal part of the lifting frame (18) is in one end connected to the lifting beam (13) and in the other end adjustably connected to the lifting vessel (1).



patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,
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II

Published:

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1 November 2001

For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

5 **Device for positioning and lifting a marine structure, particularly a platform deck.**

The present invention is related to a device for positioning and lifting a marine structure, particularly a platform deck, with the help of a lifting vessel.

10 In connection with offshore activities such as gas and oil exploitation it is usual to install platforms on the field. These platforms often consist of large and heavy platform substructures fixed to the seabed. Such a platform substructure is normally a so-called "jacket", which is a steel truss structure. On top of for example a jacket it is usual to place a platform deck, which is used
15 in connection with drilling and production. The deck also often includes living quarters.

To transport and install the jacket and the platform deck described above, for example barges have been used to transport the jacket and platform deck
20 out to the field, and large crane vessels have been used to install the platform on the field.

Heavy lift vessels using ballast to vary their draft have also been used to transport and install platforms offshore.

25 There are today a great number of offshore platforms installed to exploit oil and gas. When the oil and/or gas reservoirs are fully exploited the life span of the platform is usually over and it would in most cases be appropriate to remove the platform.

30 Some platforms are already removed, and removal of platforms will continue at an increasing pace the coming years.

15 The traditional way of removing platforms is to use large ocean going lifting cranes. The platform needs to be very thoroughly prepared prior to removal, and it must be cut into smaller parts since even the largest lifting crane vessels have limited lifting capacity. The same goes for the platform substructure (the jacket).

40 These operations are time consuming and costly, not only because the lifting cranes are large, expensive and need a large crew, but also because cutting a

platform to smaller pieces in open sea is a very complicated task. It is also a risky operation.

5 The new technology, as described in this application, can be described as "single lift technology", and will reduce the costs considerably. It will also make the operations less risky than present alternatives. Within the category "single lift technology" there are three other concepts that the applicant is aware of at the moment:

10 "Offshore Shuttle" is a vessel planned built as a frame work structure. The vessel has a significant length and the lifting of for example a platform deck is based on crossbeams spanning across the structure.

15 "Master Marine" is developing a U-shaped semi submersible with deck-structure connecting the top of columns. Lifting is based on load transfer to the deck-structure.

20 "Versatruss" is a concept involving two separate barges each supporting its own lifting frame. By pulling the barges together after positioning the lifting frames beneath the lifting points on the platform deck, the lifting of the deck can be performed. This method has already been used to remove small platform decks in calm waters.

25 One object of the present invention is to accomplish a removal operation of a platform in a fast and cost effective manner without cutting either the deck or the jacket into smaller parts. The removal operation shall be performed in a safe way where the safety of the operators is accomplished in the best possible way.

30 Another object of the present invention is that the lifting and handling equipment is as flexible as possible and that it can be easily adjusted to fit different sized platform decks. Further the equipment shall be able to lift and handle jackets of different sizes. In accordance with the invention the device is intended to be used together with a vessel, a so-called Multi Purpose Unit, MPU, which also can transport e.g. the platform deck to shore, and then
35 transfer the deck to a barge or a pier suitable to the vessel.

40 Another object of the device is that it also shall be able to be used for installation of platforms, which basically is the reverse of removal. The device should furthermore be applicable for a range of purposes where a large lifting capacity is required.

The objects described above is achieved according to the invention by a device for positioning and lifting a marine structure, particularly a platform deck, within the docking area of a lifting vessel recognised by having at least two adjustable lifting frames, each able to incline towards the middle of the docking area. Each of the lifting frames consists of an upper horizontal lifting beam, preferably situated on a level above the top of the lifting vessel. The near-vertical part of the lifting frame is connected to the lifting beam in the upper end and in the lower end hinged to the lifting vessel. The near-horizontal part of the lifting frame is in one end connected to the lifting beam and in the other end connected to the lifting vessel by a guide rail and an adjustable lock bolt.

Preferred embodiments of the device is described in the claims 2 to 9.

The present invention is described below by means of embodiments and with references to the figures, where:

Fig. 1a shows a lifting vessel employed together with the device according to the present invention,

Fig. 1b shows the lifting vessel according to the present invention, -

Fig. 2 shows the lifting vessel positioned around a jacket with a platform deck.

Fig. 3 shows a steel tubular rotation beam for lifting and rotating a jacket structure,

Fig. 4 shows a device for lifting and rotating a jacket structure for installation or removal,

Fig. 5a-5c show the vessel in connection with lifting and rotating a jacket structure where a special "cradle" is used,

Fig. 6 shows the device of the present invention in the form of lifting frames for lifting of preferably a platform deck,

Fig. 7 shows hydraulic jacks for operating the lifting frame, situated between the lifting vessel and the inclined legs of the lifting frame and the figure also shows the steel tubular beam for lifting and rotation/removal of a jacket structure,

Fig. 8 shows a hydraulic lock bolt system for locking of the lifting frame in a certain position to a guide rail connected to the lifting vessel,

Fig. 9 shows one first alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck.

Fig. 10a and 10b show a second alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck,

Fig. 11a and 11b show a third alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck,

Fig. 12, 13, 14 and 15 show step by step the operation sequence for removal of a platform deck with the help of the lifting vessel, and

Fig. 16, 17, 18, 19 and 20 show step by step the operation sequence for removal of a jacket structure with the help of the lifting vessel.

The device according to the present invention will now be described with reference to the figures, especially fig. 1a and 2.

The device according to the present invention will now be described in connection with a lifting vessel protected through the Norwegian patent application no. 99 2759 held by the applicant of the present invention. The device according to the present invention is therefore described in connection with this lifting vessel, however it shall be noted that the device can be applied with other vessels and other equipment.

The lifting vessel 1 (MPU) is developed as a floating concrete hull with a U-shaped pontoon foundation 2 containing two longitudinal pontoons 2a, 2b and a transverse pontoon 2c, and with columns 5 through the water surface for hydrostatic stability and optimal behaviour in the sea. The columns 5 are not connected structurally at the top, which is made possible by a rigid and robust hull structure. A brim 3 along the lower edge of the pontoon foundation improves further the behaviour of the vessel in the sea. The vessel 1 is specially developed for operations offshore. The U-shape of the pontoon foundation 2a, 2b, 2c enables the vessel to position itself around a platform being installed or a platform being removed, be it the platform deck or a platform substructure. The lifting operation is performed according to Archimedes' principle by ballasting/deballasting the vessel 1. The lifting is mainly performed vertically, but the vessel 1 can be inclined in all directions to enable special lifting operations.

Positioning of the vessel 1 is considered done by tugs, but thrusters can be installed to make the vessel 1 self-propulsive. The vessel 1 is designed to operate in all oceans in all parts of the world. The vessel 1 is also designed to be transported on a heavy lift ship to ease transportation over large distances.

The vessel 1 is equipped with devices specially fitted for the operations the vessel 1 is intended for. Installation and removal of platforms (platform decks and platform substructures) for the oil and gas industry are examples of operations the vessel 1 is intended for.

Installation and removal of platform substructures are mentioned above as fields of operation for the vessel 1. The vessel 1 will now be described in relation to these operations, especially in connection with the handling of jackets. Steel jackets are widely used all over the world in the oil and gas industry as substructure for offshore oil and gas production units. There are also many other situations where a jacket structure is suitable as a support structure. There will be a market for both installation and removal of jackets in the future. Below is described operations concerning removal of a jacket. For installation the operations will be performed in the reverse order.

Lifting brackets 25 are attached to the jacket legs on one side of the jacket at a certain, pre-established height. A circular tubular rotation beam 22 is fixed to the top of the transverse pontoon 2c of the lifting vessel 1. The lifting vessel 1 is positioned around the jacket with the help of tugs and active use of a device according to the present invention, a lifting frame 12. This device will be described more thoroughly later in connection with lifting devices for positioning and lifting of a platform deck. The vessel 1 is hauled to a position where the transverse pontoon 2c of the vessel 1 is positioned close to the side of the jacket where the lifting brackets 25 are attached. The lifting vessel is ballasted to the desired draft and inclination of heel so that the tubular rotation beam 22 connects with the lifting brackets 25, see fig. 4, concurrent with the lower edge of the transverse pontoon 2c bear against the jacket legs with fenders between them. The lifting brackets 25 are locked to the tubular rotation beam 22 and by deballasting the lifting vessel 1 the jacket is lifted. When the jacket is lifted clear of the seabed or foundation the lower part is lifted to the surface using wires and winches (or buoyancy modules), thereby rotating the jacket about the tubular rotation beam 22, before transportation to a new destination.

The lifting brackets 25 are made of steel of robust design and will absorb all forces introduced by the lifting and rotating operations. The lifting brackets 25 are designed to lock onto the tubular rotation beam. The lifting brackets 25 easily rotate on the tubular rotation beam 22.

5 Pre-engineering is required with regards to the strength of the jacket structure before a lift can take place. The jacket legs must be reinforced if they cannot endure the loads introduced. The lifting brackets 25 can, if necessary, be shaped with two long tubular clamps with a plate between them, so that
10 they can be mounted to the main leg and a diagonal bracing of the jacket. The brackets 25 will then absorb the forces from the tubular rotation beam 22 and distribute them to the tubular clamps, which in turn distribute the forces onward in axial direction of the legs and the braces of the jacket, and so avoiding the largest shear forces. This device must be dimensioned for
15 each individual case.

For some jackets it may be difficult to dimension the support for the brackets 25. If this is a problem a "lifting cradle" according to the invention can be used, see fig. 5. The lifting cradle is attached to the tubular rotation beam
20 22 and uses this as a rotation point as described above. The cradle 29 is a framework consisting of two triangular frames pointing outwards with a pointed end upwards, attached to the tubular rotation beam 22 on the pontoon. The triangular frames are connected with a tubular beam at the bottom of the perpendicular. The cradle 29 consists of tubes 2-3 meters in diameter
25 that are filled with water when the cradle 29 is in its lowest position and will be emptied when the lift starts. The large dimensions secure structural strength and enough buoyancy to contribute to the lift.

The lifting vessel 1 is positioned as described above and the cradle 29 will
30 embrace the jacket. Specially adjusted saddles are attached to the lower circular beam on the cradle 29, resting against the jacket legs. To avoid the jacket from sliding off the cradle 29 during the lift the jacket is connected to the tubular rotation beam 22 through brackets attached to the jacket legs. On the back of the lifting vessel 1 winches are mounted on each side of the
35 "docking area" i.e. the inner area of the U-shaped pontoon foundation surrounded by the two longitudinal pontoons 2a, 2b and the transversal pontoon 2c. Winches onboard tugs can also be used. Through pulleys wires with a hook in one end is hooked to the lower corners of the cradle 29. The cradle 29 is now lifted upwards rotating about the tubular rotation beam 22 and the
40 jacket is lifted out of the water for safe transportation to shore. An alternative method is to ballast/deballast the vessel 1 combined with the use of buoyancy modules attached to the jacket.

The present device for positioning and lifting of a platform deck will now be described with reference to the drawings. Platform decks exist in different sizes and to be able to handle them all, the lifting device must be large, strong and flexible/adjustable, with strict requirements to the shape for positioning around the substructure carrying the deck.

Lifting frame 12 according to a design of the present invention is fitted with a horizontal robust lifting beam 13 at the top and is pin-connected 21 to the top of the longitudinal pontoons 2a, 2b on each side of the docking area, see fig. 1. The lifting frame 12 consists of a near-horizontal structure 18, preferably a truss structure, going from the horizontal lifting beam 13 to the upper anchorage point 10 on the lifting vessel 1. Furthermore the lifting frame 12 consists of a vertical support structure 16, preferably a truss-work, connected in its upper end to the lifting beam 13 and connected in its lower end to the lifting vessel through an anchorage point 11, preferably a pin connection 21. The lifting frames 12, 12 in the upright position stands taller than the top of the lifting vessel 1, such that the lifting beams 13, 13 are always above the hull of the lifting vessel 1. The lifting frames 12, 12 can, with the use of the hydraulic cylinders 20, 20 connected to the lifting vessel 1 and the lifting frames 12, 12, see fig. 1a and 7, be inclined towards the middle of the docking area to position the lifting beams 13, 13 under the lifting points on the platform deck. The two lifting frames 12, 12 can be run independently. The lifting frames 12, 12 are locked in the right position before the lift starts, with hydraulic bolts 9 through holes 8 in guide rails 7 connected to each of the four columns 5 on the hull of the lifting vessel 1, see fig. 1a and 8. This ensures fixation in all directions included sea fastening during transport. Plane outer walls 6 tangentially fixed to the columns 5 are supporting the guide rails 7. The plane walls 6 are furthermore perpendicular to the direction of the connection line between two columns 5,5.

The connection between the lifting beam 13 and the deck can be carried out in different ways. Below is described three ways that ensures adequate flexibility to absorb shocks during a lift off:

- i) The lifting beam 13 can be equipped with a shock absorbing cover 14 while also placing shock absorbing cushions underneath the deck. If it is not possible to lift directly underneath the deck the upper part of the jacket can be fitted with brackets 26 with shock cushions so that the lifting beam 13 can get a proper hold, see fig. 9. Prior to lift off the jacket will be cut right below the brackets 26.

- ii) Hydraulic cylinders 30 are placed on top of the lifting beam 13 in well calculated positions to get direct contact with the lifting points on the deck structure (or brackets 26 on the upper part of the jacket). Shock absorbing cushions are placed between the deck structure and the hydraulic cylinders 30 to obtain maximum damping, see fig. 10.
- iii) "Shock cells" consisting of cylinders 35 filled with sand or another shock absorbing material is placed on top of the lifting beams 13 in well calculated positions. Conical tube stubs 37 are placed in corresponding positions on the deck structure. The conical tube stubs 37 absorb shocks when they penetrate the sand-filled cylinders 35, see fig. 11a. An alternative is that both the tube stubs 37 and the shock cells 35 are mounted on the deck structure, see fig. 11b.
- The MPU 1 is positioned around a jacket structure with deck and is made ready for lift off and removal of the deck. The lifting frames 12, 12 on each side of the docking area is actively used for positioning by inclining them against the jacket with the help of hydraulically controlled arms 20, see fig. 2. Additionally the positioning is done by tugs. The lifting frames 12, 12 are pulled back into lifting position when the MPU 1 is in the right position, as described above. The MPU 1 is then deballasted slowly until the lifting beams 13 are touching the lifting points. Compensation for the vertical motions of the MPU 1 is partly done by flexible shock cushions mounted on the lifting beams and lifting points, and partly by the use of a flushing system that ensures a quick load transfer. When the deck has a safe clearance to the jacket the MPU is pulled away from the jacket before ballasted down to transport draft.

The flushing system consists of flushing (ballast) tanks 4 above the waterline with large area quick release trapdoors that enable the water to flush out. Trapdoors on different levels enable multiphase flushing, i.e. flushing in several steps.

This example describes the operations for removal of a platform deck. The different operations are illustrated in a sequence of figures; fig. 12-15:

- i) Positioning around a jacket with a deck.
With the help of tugs the MPU 1 is positioned around the jacket. The lifting frames 12, 12 are in upright position with good clearance to the jacket. The draft of the vessel 1 ensures good clearance to the deck, see fig. 12.

- ii) Using the lifting frames 12, 12 to fine adjust the position around the jacket.
When the MPU 1 is approaching the correct position the lifting frames 12, 12 are inclined against the jacket to dampen the horizontal motions of the MPU 1 and also to fine-adjust the position. This is done by active use of hydraulics, see fig. 13.
- 5
iii) Deballasting the MPU 1, ready for lift-off.
The MPU 1 is deballasted while the lifting frames 12, 12 glide along the jacket structure to dampen the horizontal motions. The deballasting proceeds until the lifting frames 12, 12 are right under the lifting points on the deck. The lifting frames 12, 12 are then locked into position and MPU 1 is ready for lifting off the platform deck, see fig. 14.
- 10
iv) Lift-off of the deck
When the MPU 1 is ready to lift off the deck, water in the flushing tanks 4 are let out quickly by opening the quick release trapdoors in the columns 5 thereby achieving a rapid lift. The deck is prepared in advance by cutting the connections between the deck and the jacket, see fig. 15.
- 15
v) Ready for transportation to shore
After lift-off the MPU 1 is pulled away from the remaining jacket. The MPU 1 is deballasted down to transportation draft when it is clear from the jacket. If necessary additional sea fastening to the locking of the lifting frames 12, 12 are added and the transportation to shore can start. It is also possible to transfer the deck to a barge for transportation to shore so that the MPU 1 is immediately available for new operations (e.g. removal of the jacket).
- 20
25

This example describes the operations for removal of a jacket structure. The different operations are illustrated in a sequence of figures; fig. 16-20:

- 30
vi) Positioning around a jacket (without a deck).
With help from tugs the MPU 1 is positioned around the jacket. The lifting frames 12, 12 are in upright position with good clearance to the jacket, see fig. 16.
- 35
vii) Using the lifting frames 12, 12 to fine adjust the position around the jacket.
When the MPU 1 is approaching the correct position the lifting frames 12, 12 are inclined against the jacket to dampen the horizontal motions of the MPU 1 and also to fine-adjust the position. This is done by active use of hydraulics, see fig. 17.
- 40
viii) The MPU is inclined and deballasted, ready for lift-off

The MPU 1 is inclined and deballasted until the tubular rotation beam 22, situated on top of the transversal pontoon 2c, gets a hold of the brackets 25 pre-installed on the jacket, see fig. 18.

ix) **Lift-off**

5 When the MPU 1 is ready to lift off the jacket, water in the flushing tanks 4 are let out quickly by opening the quick release trapdoors in the columns 5 thereby achieving a rapid lift. The jacket is prepared in advance by cutting the jacket legs, piles, risers etc., see fig. 19.

x) **Tilting of the jacket, ready for transportation**

10 After lift-off, the jacket is rotated to a near-horizontal position with the use of winches and wires mounted on the aft of the MPU 1 or winches and wires onboard rigs, see fig. 20. An alternative method is to attach buoyancy modules to the jacket. After sea fastening the transportation to shore can start. An alternative is to transfer the jacket
15 to a barge for transportation to shore so that the MPU 1 is immediately available for new operations.

PATENT CLAIMS

- 5 1. A device for positioning and lifting a marine structure, particularly a platform deck, with the use of a U-shaped lifting vessel (1), characterised by having at least two adjustable lifting frames (12,12), each able to incline towards the middle of the docking area. Each of the lifting frames (12) consists of an upper horizontal lifting beam (13), preferably situated on a level above the top of the lifting vessel (1). The near-vertical part of the lifting frame (16) is connected to the lifting beam (13) in the upper end and in the lower end hinged (21) to the lifting vessel (1). The near-horizontal part of the lifting frame (18) is in one end connected to the lifting beam (13) and in the other end adjustably connected to the lifting vessel (1).
- 10 2. A device according to claim 1, characterised by a shock absorbing cover (14) on the horizontal lifting beam (13).
- 15 3. A device according to claim 2, characterised by the shock absorbing cover (14) is made of rubber.
- 20 4. A device according to claim 1, characterised by the lifting beam (13) is equipped with hydraulic cylinders (30) in pre-defined lifting point positions.
- 25 5. A device according to claim 1, characterised by the lifting beam (13) is equipped with sand-filled cylinders (35) in pre-defined lifting point positions since the sand-filled cylinders (35) are corresponding with the belonging conical tubular stubs (37) attached on the platform deck.
- 30 6. A device according to all of the above claims, characterised by the lifting frame (16) is a truss structure.
- 35 7. A device according to all of the above claims, characterised by the near-horizontal structure (18) is a truss structure.
- 40 8. A device according to all of the above claims,

characterised by the near-horizontal structures (18) having adjustable connection points to the lifting vessel (1) consisting of a hydraulically operated bolt (9) going into a corresponding hole (8) in a guiding rail (7) attached to the lifting vessel (1).

5

9. A device according to all of the above claims, characterised by the lifting frames (16) in an area above the jointed bearing (21) are equipped with adjustable hydraulic arms (20) connected to the lifting vessel (1).

10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 00/00198

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B63B 35/44, E02B 17/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B63B, E02B

Documentation searched other than minimum documentation in the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5829919 A (HEEREMA), 3 November 1998 (03.11.98) --	1-9
A	US 4714382 A (KHACHATURJAN), 22 December 1987 (22.12.87) --	1-9
A	US 4744697 A (COPPENS), 17 May 1988 (17.05.88) -----	1-9

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document relating to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, each of which is being obvious to a person skilled in the art

Z document member of the same patent family

Date of the actual completion of the international search

13 October 2000

Date of mailing of the international search report

18-10-2000

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Form PCT ISA 210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/08/00

International application No.
PCT/NO 00/00198

Patent document cited in search report			Publication date		Patent family member(s)		Publication date	
US	5829919	A	03/11/98	AU	710810	B	30/09/99	
				AU	7054096	A	08/05/97	
				BE	1009792	A	05/08/97	
				BR	9605399	A	28/07/98	
				CA	2189306	A	04/05/97	
				DK	121796	A	04/05/97	
				GB	2306407	A,B	07/05/97	
				GB	9622645	D	00/00/00	
				NL	1001778	C	00/00/00	
				NO	964624	A	05/05/97	
				SG	65624	A	22/06/99	
<hr/>								
US	4714382	A	22/12/87	NONE				
<hr/>								
US	4744697	A	17/05/88	GB	2156286	A	09/10/85	
				GB	2174648	A,B	12/11/86	
				GB	2174743	A,B	12/11/86	
				GB	8510822	D	00/00/00	
				GB	8510370	D	00/00/00	
				NO	171495	B,C	14/12/92	
				NO	861687	A	30/10/86	
				NO	861688	A	30/10/86	
				NO	861689	A	30/10/86	
				GB	2165187	A	09/04/86	
GB	8514180	D	00/00/00					
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PATENT COOPERATION TREATY

to the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

Bryn & Aarfplot AS
P.O. Box 449 Sentrum
N-0104 Oslo
Norway

NOTIFICATION OF TRANSMITTAL OF
INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing
(day/month/year) 24-09-2001

Applicant's or agent's file reference
102779/SAO

IMPORTANT NOTIFICATION

International application No.
PCT/NO00/00198

International filing date (day/month/year)
07-06-2000

Priority date (day/month/year)
07-06-1999

Applicant
MPU Enterprise AS
et al

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/ID/301).

where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

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Form PCT/IPEA/416 (July 1992)

EV011019467US

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 102779/SAO	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/NO00/00198	International filing date (day/month/year) 07.06.2000	Priority date (day/month/year) 07.06.1999
International Patent Classification (IPC) or national classification and IPC B63B 35/44, E02B 17/02		
Applicant MPU Enterprise AS et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 13 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 04.01.2001	Date of completion of this report 21.09.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 712 88	Authorized officer: Christer Jönsson/js Telephone No. 08-782 25 00

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/NO00/00198

1. Basis of the report

1. With regard to the elements of the international application:*

- ☐ the international application as originally filed
- ☒ the description:
 pages _____, as originally filed
 pages _____, filed with the demand
 pages 1-11, filed with the letter of 09.07.2001
- ☒ the claims:
 pages _____, as originally filed
 pages _____, as amended (together with any statement) under article 19
 pages _____, filed with the demand
 pages 1-2, filed with the letter of 09.07.2001
- ☒ the drawings:
 pages 1-13, as originally filed
 pages _____, filed with the demand
 pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
 pages _____, as originally filed
 pages _____, filed with the demand
 pages _____, filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item. These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig. _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheets containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/NO00/00190

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-9	YES
	Claims		NO
Inventive step (IS)	Claims	1-9	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-9	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report:

1. US 5829919 A (HEEREMA)
2. US 4714382 A (KHACHATURIAN)
3. US 4744697 A (COPPENS)

The documents cited in the International Search Report represent background art.

The invention defined in claims 1-9 is not disclosed by any of these documents.

None of the cited documents gives any indication towards the claimed device for positioning and lifting a marine structure with the use of a U-shaped ballastable lifting vessel comprising two or more adjustable lifting frames that are incline towards the middle of the docking area having a lifting beam, a near-vertical support structure and a near-horizontal part as stated in claim 1. No relevant combination of the cited documents would lead a person skilled in the art to the invention defined in the claims.

Therefore, the invention defined in claims 1-9 is novel and is considered to involve an inventive step. It is also considered to be industrially applicable.

SAO/n/102779

PCT/NO00/00198

Device for positioning and lifting a marine structure, particularly a platform deck.

The present invention is related to a device for positioning and lifting a marine structure, particularly a platform deck, with the use of a lifting vessel.

In connection with offshore activities such as gas and oil exploitation it is usual to install platforms on the field. These platforms often consist of large and heavy platform substructures fixed to the seabed. Such a platform substructure is normally a so-called "jacket", which is a steel truss structure. On top of for example a jacket it is usual to place a platform deck, which is used in connection with drilling and production. The deck also often includes living quarters.

To transport and install the jacket and the platform deck described above, for example barges have been used to transport the jacket and platform deck out to the field, and large crane vessels have been used to install the platform on the field.

Heavy lift vessels using ballast to vary their draft have also been used to transport and install platforms offshore.

There are today a great number of offshore platforms installed to exploit oil and gas. When the oil and/or gas reservoirs are fully exploited the life span of the platform is usually over and it would in most cases be appropriate to remove the platform.

Some platforms are already removed, and removal of platforms will continue at an increasing pace the coming years.

AMENDED SHEET

The traditional way of removing platforms is to use large ocean going lifting cranes. The platform needs to be very thoroughly prepared prior to removal, and it must be cut into smaller parts since even the largest lifting crane vessels have limited lifting capacity. The same goes for the platform substructure (the jacket).

These operations are time consuming and costly, not only because the lifting cranes are large, expensive and need a large crew, but also because cutting a platform to smaller pieces in open sea is a very complicated task. It is also a risky operation.

The new technology, as described in this application, can be described as "single lift technology", and will reduce the costs considerably. It will also make the operations less risky than present alternatives. Within the category "single lift technology" there are three other concepts that the applicant is aware of at the moment:

"Offshore Shuttle" is a vessel planned built as a frame work structure. The vessel has a significant length and the lifting of for example a platform deck is based on crossbeams spanning across the structure.

"Master Marine" is developing a U-shaped semi submersible with deck-structure connecting the top of columns. Lifting is based on load transfer to the deck-structure.

"Versatruss" is a concept involving two separate barges each supporting its own lifting frame. By pulling the barges together after positioning the lifting frames beneath the lifting points on the platform deck, the lifting of the deck can be performed. This method has already been used to remove small platform decks in calm waters.

One object of the present invention is to accomplish a removal operation of a platform in a fast and cost effective manner without cutting either the deck or

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the jacket into smaller parts. The removal operation shall be performed in a safe way where the safety of the operators is accomplished in the best possible way.

Another object of the present invention is that the lifting and handling equipment is as flexible as possible and that it can be easily adjusted to fit different sized platform decks. Further the equipment shall be able to lift and handle jackets of different sizes. In accordance with the invention the device is intended to be used together with a vessel, a so-called Multi Purpose Unit, MPU, which also can transport e.g. the platform deck to shore, and then transfer the deck to a barge or a pier suitable to the vessel.

Another object of the device is that it also shall be able to be used for installation of platforms, which basically is the reverse of removal. The device should furthermore be applicable for a range of purposes where a large lifting capacity is required.

The objects described above is achieved according to the invention by a device for positioning and lifting a marine structure, particularly a platform deck, with the use of a U-shaped ballastable lifting vessel, comprising at least two adjustable lifting frames, each able to incline towards the middle of the docking area, as comprising each of the lifting frames consists of an upper horizontal lifting beam, preferably situated on a level above the top of the lifting vessel, a near-support structure of which in its upper end is connected to the lifting beam and which in its lower end is hinged to the lifting vessel, and a near-horizontal part which in its first end is connected to the lifting beam and which in its second end is adjustably connected to the lifting vessel.

Preferred embodiments of the device are described in the claims 2 to 9.

The present invention is described below by means of embodiments and with references to the figures, where:

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Fig. 1a shows a lifting vessel employed together with the device according to the present invention,

Fig. 1b shows the lifting vessel according to the present invention,

Fig. 2 shows the lifting vessel positioned around a jacket with a platform deck,

Fig. 3 shows a device according to the invention, a steel tubular rotation beam for lifting and rotating a jacket structure,

Fig. 4 shows a device for lifting and rotating a jacket structure for installation or removal,

Fig. 5a-5c show the vessel in connection with lifting and rotating a jacket structure where a special "cradle" is used,

Fig. 6 shows the lifting frames for lifting of preferably a platform deck,

Fig. 7 shows hydraulic jacks for operating the lifting frame, situated between the lifting vessel and the inclined legs of the lifting frame and the figure also shows the steel tubular beam for lifting and rotation/removal of a jacket structure,

Fig. 8 shows a hydraulic lock bolt system for locking of the lifting frame in a certain position to a guide rail connected to the lifting vessel,

Fig. 9 shows one first alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck,

Fig. 10a and 10b show a second alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck,

Fig. 11a and 11b show a third alternative for a connection between the lifting frame and the jacket structure for removal of a platform deck,

Fig. 12, 13, 14 and 15 show step by step the operation sequence for removal of a platform deck with the help of the lifting vessel, and

Fig. 16, 17, 18, 19 and 20 show step by step the operation sequence for removal of a jacket structure with the help of the lifting vessel.

The device according to the invention will now be described with reference to the figures, especially fig. 1a and 2.

The device according to the present invention will now be described in connection with a lifting vessel protected through the Norwegian patent application no. 99 2759 held by the applicant of the present invention. The device according to the present invention is therefore described in connection with this lifting vessel, however it shall be noted that the device can be applied with other vessels and other equipment.

The lifting vessel 1 (MPU) is developed as a floating concrete hull with a U-shaped pontoon foundation 2 containing two longitudinal pontoons 2a, 2b and a transverse pontoon 2c, and with columns 5 through the water surface for hydrostatic stability and optimal behaviour in the sea. The columns 5 are not connected structurally at the top, which is made possible by a rigid and robust hull structure. A brim 3 along the lower edge of the pontoon foundation improves further the behaviour of the vessel in the sea. The vessel 1 is specially developed for operations offshore. The U-shape of the pontoon foundation 2a, 2b, 2c enables the vessel to position itself around a platform being installed or a platform being removed, be it the platform deck or a platform substructure. The lifting operation is performed according to Archimedes' principle by ballasting/deballasting the vessel 1. The lifting is mainly performed vertically, but the vessel 1 can be inclined in all directions to enable special lifting operations.

Positioning of the vessel 1 is considered done by tugs, but thrusters can be installed to make the vessel 1 self-propulsive. The vessel 1 is designed to operate in all oceans in all parts of the world. The vessel 1 is also designed to be transported on a heavy lift ship to ease transportation over large distances.

The vessel 1 is equipped with devices specially fitted for the operations the vessel 1 is intended for. Installation and removal of platforms (platform decks and platform substructures) for the oil and gas industry are examples of operations the vessel 1 is intended for.

Installation and removal of platform substructures are mentioned above as fields of operation for the vessel 1. The vessel 1 will now be described in relation to these operations, especially in connection with the handling of jackets. Steel jackets are widely used all over the world in the oil and gas industry as substructure for offshore oil and gas production units. There are also many other situations where a jacket structure is suitable as

AMENDED SHEET

a support structure. There will be a market for both installation and removal of jackets in the future. Below is described operations concerning removal of a jacket. For installation the operations will be performed in the reverse order.

According to the present invention lifting brackets 25 are attached to the jacket legs on one side of the jacket at a certain, pre-established height. A circular tubular rotation beam 22, according to the invention, is fixed to the top of the transverse pontoon 2c of the lifting vessel 1. The lifting vessel 1 is positioned around the jacket with the help of tugs and active use of a lifting frame 12 according to the present invention. This device will be described more thoroughly later in connection with lifting devices for positioning and lifting of a platform deck. The vessel 1 is hauled to a position where the transverse pontoon 2c of the vessel 1 is positioned close to the side of the jacket where the lifting brackets 25 are attached. The lifting vessel is ballasted to the desired draft and inclination of heel so that the tubular rotation beam 22 connects with the lifting brackets 25, see fig. 4, concurrent with the lower edge of the transverse pontoon 2c bear against the jacket legs with fenders between them. The lifting brackets 25 are locked to the tubular rotation beam 22 and by deballasting the lifting vessel 1 the jacket is lifted. When the jacket is lifted clear of the seabed or foundation the lower part is lifted to the surface using wires and winches (or buoyancy modules), thereby rotating the jacket about the tubular rotation beam 22, before transportation to a new destination.

The lifting brackets 25 are made of steel of robust design and will absorb all forces introduced by the lifting and rotating operations. The lifting brackets 25 are designed to lock onto the tubular rotation beam. The lifting brackets 25 easily rotate on the tubular rotation beam 22.

Pre-engineering is required with regards to the strength of the jacket structure before a lift can take place. The jacket legs must be reinforced if they cannot endure the loads introduced. The lifting brackets 25 can, if necessary, be shaped with two long tubular clamps with a plate between them, so that they can be mounted to the main leg and a diagonal bracing of the jacket. The brackets 25 will then absorb the forces from the tubular rotation beam 22 and distribute them to the tubular clamps, which in turn distribute the forces onward in axial direction of the legs and the braces of the jacket, and so avoiding the largest shear forces. This device must be dimensioned for each individual case.

For some jackets it may be difficult to dimension the support for the brackets 25. If this is a problem a "lifting cradle" according to the

AMENDED SHEET

invention can be used, see fig. 5. The lifting cradle is attached to the tubular rotation beam 22 and uses this as a rotation point as described above. The cradle 29 is a framework consisting of two triangular frames pointing outwards with a pointed end upwards, attached to the tubular rotation beam 22 on the pontoon. The triangular frames are connected with a tubular beam at the bottom of the perpendicular. The cradle 29 consists of tubes 2-3 meters in diameter that are filled with water when the cradle 29 is in its lowest position and will be emptied when the lift starts. The large dimensions secure structural strength and enough buoyancy to contribute to the lift.

The lifting vessel 1 is positioned as described above and the cradle 29 will embrace the jacket. Specially adjusted saddles are attached to the lower circular beam on the cradle 29, resting against the jacket legs. To avoid the jacket from sliding off the cradle 29 during the lift the jacket is connected to the tubular rotation beam 22 through brackets attached to the jacket legs. On the back of the lifting vessel 1 winches are mounted on each side of the "docking area" i.e. the inner area of the U-shaped pontoon foundation surrounded by the two longitudinal pontoons 2a, 2b and the transversal pontoon 2c. Winches onboard tugs can also be used. Through pulleys wires with a hook in one end is hooked to the lower corners of the cradle 29. The cradle 29 is now lifted upwards rotating about the tubular rotation beam 22 and the jacket is lifted out of the water for safe transportation to shore. An alternative method is to ballast/deballast the vessel 1 combined with the use of buoyancy modules attached to the jacket.

The present device for positioning and lifting of a platform deck will now be described with reference to the drawings. Platform decks exist in different sizes and to be able to handle them all, the lifting device must be large, strong and flexible/adjustable, with strict requirements in the shape for positioning around the substructure carrying the deck.

A lifting frame 12 fitted with a horizontal robust lifting beam 13 at the top is pin-connected 21 to the top of the longitudinal pontoons 2a, 2b on each side of the docking area, see fig. 1. The lifting frame 12 consists of a horizontal structure 18, preferably a truss structure, going from the horizontal lifting beam 13 to the upper anchorage point 10 on the lifting vessel 1. Furthermore the lifting frame 12 consists of a vertical support structure 16, preferably a truss-work, connected in its upper end to the lifting beam 13 and connected in its lower end to the lifting vessel through an anchorage point 11, preferably a pin connection 21. The lifting frames 12, 12 in the upright position stands taller than the top of

the lifting vessel 1, such that the lifting beams 13, 13 are always above the hull of the lifting vessel 1. The lifting frames 12, 12 can, with the use of the hydraulic cylinders 20, 20 connected to the lifting vessel 1 and the lifting frames 12, 12, see fig. 1a and 7, be inclined towards the middle of the docking area to position the lifting beams 13, 13 under the lifting points on the platform deck. The two lifting frames 12, 12 can be run independently. The lifting frames 12, 12 are locked in the right position before the lift starts, with hydraulic bolts 9 through holes 8 in guide rails 7 connected to each of the four columns 5 on the hull of the lifting vessel 1, see fig. 1a and 8. This ensures fixation in all directions included sea fastening during transport. Plane outer walls 6 tangentially fixed to the columns 5 are supporting the guide rails 7. The plane walls 6 are furthermore perpendicular to the direction of the connection line between two columns 5,5.

The connection between the lifting beam 13 and the deck can be carried out in different ways. Below is described three ways that ensures adequate flexibility to absorb shocks during a lift off:

- i) The lifting beam 13 can be equipped with a shock absorbing cover 14 while also placing shock absorbing cushions underneath the deck. If it is not possible to lift directly underneath the deck the upper part of the jacket can be fitted with brackets 26 with shock cushions so that the lifting beam 13 can get a proper hold, see fig. 9. Prior to lift off the jacket will be cut right below the brackets 26.
- ii) Hydraulic cylinders 30 are placed on top of the lifting beam 13 in well calculated positions to get direct contact with the lifting points on the deck structure (or brackets 26 on the upper part of the jacket). Shock absorbing cushions are placed between the deck structure and the hydraulic cylinders 30 to obtain maximum damping, see fig. 10.
- iii) "Shock cells" consisting of cylinders 35 filled with sand or another shock absorbing material is placed on top of the lifting beams 13 in well calculated positions. Conical tube stubs 37 are placed in corresponding positions on the deck structure. The conical tube stubs 37 absorb shocks when they penetrate the sand-filled cylinders 35, see fig. 11a. An alternative is that both the tube stubs 37 and the shock cells 35 are mounted on the deck structure, see fig. 11b.

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The MPU 1 is positioned around a jacket structure with deck and is made ready for lift off and removal of the deck. The lifting frames 12, 12 on each side of the docking area is actively used for positioning by inclining them against the jacket with the help of hydraulically controlled arms 20, see fig. 2. Additionally the positioning is done by tugs. The lifting frames 12, 12 are pulled back into lifting position when the MPU 1 is in the right position, as described above. The MPU 1 is then deballasted slowly until the lifting beams 13 are touching the lifting points. Compensation for the vertical motions of the MPU 1 is partly done by flexible shock cushions mounted on the lifting beams and lifting points, and partly by the use of a flushing system that ensures a quick load transfer. When the deck has a safe clearance to the jacket the MPU is pulled away from the jacket before ballasted down to transport draft.

The flushing system consists of flushing (ballast) tanks 4 above the waterline with large area quick release trapdoors that enable the water to flush out. Trapdoors on different levels enable multiphase flushing, i.e. flushing in several steps.

This example describes the operations for removal of a platform deck. The different operations are illustrated in a sequence of figures; fig. 12-15:

- i) Positioning around a jacket with a deck.
With the help of tugs the MPU 1 is positioned around the jacket. The lifting frames 12, 12 are in upright position with good clearance to the jacket. The draft of the vessel 1 ensures good clearance to the deck, see fig. 12.
- ii) Using the lifting frames 12, 12 to fine adjust the position around the jacket.
When the MPU 1 is approaching the correct position the lifting frames 12, 12 are inclined against the jacket to dampen the horizontal motions of the MPU 1 and also to fine-adjust the position. This is done by active use of hydraulics, see fig. 13.
- iii) Deballasting the MPU 1, ready for lift-off.
The MPU 1 is deballasted while the lifting frames 12, 12 glide along the jacket structure to dampen the horizontal motions. The deballasting proceeds until the lifting frames 12, 12 are right under the lifting points on the deck. The lifting frames 12, 12 are then locked into position and MPU 1 is ready for lifting off the platform deck, see fig. 14.
- iv) Lift-off of the deck

When the MPU 1 is ready to lift off the deck, water in the flushing tanks 4 are let out quickly by opening the quick release trapdoors in the columns 5 thereby achieving a rapid lift. The deck is prepared in advance by cutting the connections between the deck and the jacket, see fig. 15.

- v) Ready for transportation to shore
After lift-off the MPU 1 is pulled away from the remaining jacket. The MPU 1 is deballasted down to transportation draft when it is clear from the jacket. If necessary additional sea fastening to the locking of the lifting frames 12, 12 are added and the transportation to shore can start. It is also possible to transfer the deck to a barge for transportation to shore so that the MPU 1 is immediately available for new operations (e.g. removal of the jacket).

This example describes the operations for removal of a jacket structure. The different operations are illustrated in a sequence of figures; fig. 16-20:

- vi) Positioning around a jacket (without a deck).
With help from tugs the MPU 1 is positioned around the jacket. The lifting frames 12, 12 are in upright position with good clearance to the jacket, see fig. 16.
- vii) Using the lifting frames 12, 12 to fine adjust the position around the jacket.
When the MPU 1 is approaching the correct position the lifting frames 12, 12 are inclined against the jacket to dampen the horizontal motions of the MPU 1 and also to fine-adjust the position. This is done by active use of hydraulics, see fig. 17.
- viii) The MPU is inclined and deballasted, ready for lift-off
The MPU 1 is inclined and deballasted until the tubular rotation beam 22, situated on top of the transversal pontoon 2c, gets a hold of the brackets 25 pre-installed on the jacket, see fig. 18.
- ix) Lift-off
When the MPU 1 is ready to lift off the jacket, water in the flushing tanks 4 are let out quickly by opening the quick release trapdoors in the columns 5 thereby achieving a rapid lift. The jacket is prepared in advance by cutting the jacket legs, piles, risers etc., see fig. 19.
- x) Tilting of the jacket, ready for transportation
After lift-off, the jacket is rotated to a near-horizontal position with the use of winches and wires mounted on the aft of the MPU 1 or winches and wires onboard tugs, see fig. 20. An alternative method is to attach buoyancy modules to the jacket. After sea fastening the

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transportation to shore can start. An alternative is to transfer the jacket to a barge for transportation to shore so that the MPU 1 is immediately available for new operations.

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PATENT CLAIMS

1. A device for positioning and lifting a marine structure, particularly a platform deck, with the use of a U-shaped ballastable lifting vessel (1), characterised by comprising at least two adjustable lifting frames (12,12), each able to incline towards the middle of the docking area, as each of the lifting frames (12) consists of an upper horizontal lifting beam (13), preferably situated on a level above the top of the lifting vessel (1), a near-vertical support structure (16) which in its upper end is connected to the lifting beam (13) and which in its lower end is hinged (21) to the lifting vessel (1), and a near horizontal part (18) which in its first end is connected to the lifting beam (13) and which in its second end is adjustably connected to the lifting vessel (1).
2. A device according to claim 1, characterised in that the upper horizontal lifting beam (13) is covered with an external shock absorbing cover (14).
3. A device according to claim 2, characterised in that the shock absorbing cover (14) is made of rubber.
4. A device according to claim 1, characterised in that the lifting beam (13) is provided with hydraulic cylinders (30) in pre-defined lifting point positions.
5. A device according to claim 1, characterised in that the lifting beam (13) is provided with sand-filled cylinders (35) in pre-defined lifting point positions as the sand-filled cylinders (35) co-operate with the corresponding conical tubular stubs (37) on the platform deck.

6. A device according to any of the preceding claims,
characterised in that the near-vertical part (16) is a truss
structure.
7. A device according to any of the preceding claims,
characterised in that the near-horizontal part (18) is a truss
structure.
8. A device according to any of the preceding claims,
characterised in that the adjustable connection of the near-
horizontal part (18) of the lifting vessel (1) is in the form of a hydrauli-
cally operated bolt (9) inserted into a corresponding hole (8) in a
guiding rail (7) on the lifting vessel (1).
9. A device according to any of the preceding claims,
characterised in that the near-vertical part (16) in an area
above the hinge point (21) is equipped with adjustable hydraulic arms
(20) connected to the lifting vessel (1).



PATENTSTYRET
Styret for det industrielle rettsvern

NORSK GRANSKINGSRAPPORT
NORWEGIAN SEARCH REPORT

Patentsøknad nr.
Patent application no.

19992761

Kategori/ Category*	Anførte publikasjoner: Cited documents:	Relevant mot krav Relevant to claim(s)
Y	US 5,975,807 <i>Encl.</i> (Hele dokumentet)	1
Y	US 5,829,919 <i>cited in ISR.</i> (Hele dokumentet)	1
Y	US 5,800,093 <i>encl.</i> (Hele dokumentet)	1
Y	US 5,609,441 <i>encl.</i> (Hele dokumentet)	1
Y	US 5,607,260 <i>encl.</i> (Hele dokumentet)	1
Y	US 4,973,200 <i>encl.</i> (Hele dokumentet)	1
Y	US 4,744,697 <i>cited in ISR</i> (Hele dokumentet)	1
X	US 4,714,382 encl. <i>cited in ISR</i> (Hele dokumentet)	1
Y	GB 2 165 188 A <i>encl.</i> (Hele dokumentet)	1
A	SE 467 156 B <i>encl.</i> (Hele dokumentet)	1
Y	WO 98/24980 <i>encl.</i> (Hele dokumentet)	1
Y	NO 160424 B <i>patent family of US 4556004 - enclosed</i> (Hele dokumentet)	1
Y	NO 306385 B1 <i>- encl. with translation of abstract</i> (Hele dokumentet)	1
*Dokumentkategori:		*Category of cited document:
X: særlig relevant alene		X: particularly relevant if taken alone
Y: særlig relevant dersom det kombineres med annet dokument i samme kategori		Y: particularly relevant if combined with another document of the same category
A: bakgrunnsteknikk		A: technological background
D: anført i beskrivelsen		D: document cited in the application
E: dokument med tidligere prioritet (PL § 2.2.3)		E: earlier patent document, but published on, or after the filing date
&: publikasjon i samme patentfamilie		&: member of the same family

Rapport utferdiget/date of report: 1999.11.18

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 102779/SAO	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/NO00/00198	International filing date (day/month/year) 07.06.2000	Priority date (day/month/year) 07.06.1999
International Patent Classification (IPC) or national classification and IPC ₇ B63B 35/44, E02B 17/02		
Applicant MPU Enterprise AS et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 13 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 04.01.2001	Date of completion of this report 21.09.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Christer Jönsson/js Telephone No. 08-782 25 00

I. Basis of the report

1. With regard to the **elements** of the international application:*

- ☐ the international application as originally filed
- ☒ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages 1-11, filed with the letter of 09.07.2001
- ☒ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages 1-2, filed with the letter of 09.07.2001
- ☒ the drawings:
pages 1-13, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims	<u>1-9</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-9</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-9</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report:

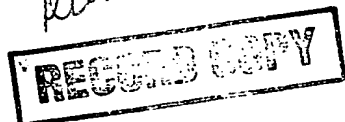
1. US 5829919 A (HEEREMA)
2. US 4714382 A (KHACHATURIAN)
3. US 4744697 A (COPPENS)

The documents cited in the International Search Report represent background art.

The invention defined in claims 1-9 is not disclosed by any of these documents.

None of the cited documents gives any indication towards the claimed device for positioning and lifting a marine structure with the use of a U-shaped ballastable lifting vessel comprising two or more adjustable lifting frames that are incline towards the middle of the docking area having a lifting beam, a near-vertical support structure and a near-horizontal part as stated in claim 1. No relevant combination of the cited documents would lead a person skilled in the art to the invention defined in the claims.

Therefore, the invention defined in claims 1-9 is novel and is considered to involve an inventive step. It is also considered to be industrially applicable.




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PCT REQUEST

102779/SAO

Original (for SUBMISSION) - printed on 07.06.2000 10:51:51 AM

0	For receiving Office use only	
0-1	International Application No.	PCT/NO 00 / 00198
0-2	International Filing Date	- 7 JUNI 2000 (07.06.2000)
0-3	Name of receiving Office and "PCT International Application"	 PATENTSTYRET Styret for det industrielle rettsvern ► PCT International application
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.90 (updated 10.05.2000)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	Norwegian Patent Office (RO/NO)
0-7	Applicant's or agent's file reference	102779/SAO
I	Title of invention	DEVICE FOR POSITIONING AND LIFTING A MARINE STRUCTURE, PARTICULARLY A PLATFORM DECK.
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	MPU ENTERPRISE AS
II-5	Address:	P.O.Box 17 N-1324 Lysaker Norway
II-6	State of nationality	NO
II-7	State of residence	NO
III-1	Applicant and/or inventor	
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III-1-2	Applicant for	US only
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III-1-6	State of nationality	NO
III-1-7	State of residence	NO

PCT REQUEST

102779/SAO

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III-2	Applicant and/or inventor	
III-2-1	This person is:	applicant and inventor
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III-2-4	Name (LAST, First)	OLSEN, Tor, Ole
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III-2-6	State of nationality	NO
III-2-7	State of residence	NO
III-3	Applicant and/or inventor	
III-3-1	This person is:	applicant and inventor
III-3-2	Applicant for	US only
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III-3-6	State of nationality	NO
III-3-7	State of residence	NO
III-4	Applicant and/or inventor	
III-4-1	This person is:	applicant and inventor
III-4-2	Applicant for	US only
III-4-4	Name (LAST, First)	HÆREID, Kåre, O.
III-4-5	Address:	Bestumvn. 75a N-0283 Oslo Norway
III-4-6	State of nationality	NO
III-4-7	State of residence	NO
III-5	Applicant and/or inventor	
III-5-1	This person is:	applicant and inventor
III-5-2	Applicant for	US only
III-5-4	Name (LAST, First)	HANSEN, Jörn, Bastholm
III-5-5	Address:	Kalkfjellet 45 N-1387 Asker Norway
III-5-6	State of nationality	NO
III-5-7	State of residence	NO
III-6	Applicant and/or inventor	
III-6-1	This person is:	applicant and inventor
III-6-2	Applicant for	US only
III-6-4	Name (LAST, First)	LANDBÖ, Trond
III-6-5	Address:	Vestlivn. 20B N-1344 Haslum Norway
III-6-6	State of nationality	NO
III-6-7	State of residence	NO

PCT REQUEST

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IV-1	Agent or common representative; or address for correspondence The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	BRYN & AARFLOT AS
IV-1-2	Address:	P.O.Box 449 Sentrum N-0104 Oslo Norway
IV-1-3	Telephone No.	22 00 31 00
IV-1-4	Facsimile No.	22 00 31 31
IV-1-5	e-mail	email@baa.no
V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW MZ SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	

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V-6	Exclusion(s) from precautionary designations	NONE	
VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	07 June 1999 (07.06.1999)	
VI-1-2	Number	1999 2761	
VI-1-3	Country	NO	
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)	
VII-2	Request to use results of earlier search; reference to that search		
VII-2-1	Date	24 November 1999 (24.11.1999)	
VII-2-2	Number	1999 2761	
VII-2-3	Country (or regional Office)	NO	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	5	-
VIII-2	Description	10	-
VIII-3	Claims	2	-
VIII-4	Abstract	1	102779abs.txt
VIII-5	Drawings	13	-
VIII-7	TOTAL	31	
VIII-8	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-17	Other (specified):	Copy of Official Action	-
VIII-18	Figure of the drawings which should accompany the abstract	1a	
VIII-19	Language of filing of the international application	Norwegian	
IX-1	Signature of applicant or agent	<i>Svein Arne Olsen</i>	
IX-1-1	Name	BRYN & AARFLOT AS	
IX-1-2	Name of signatory	Svein Arne Olsen	
IX-1-3	Capacity	Patent Attorney	

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	- 7 JUNI 2000 (07.06.2000)
10-2	Drawings:	
10-2-1	Received	Received
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	

PCT REQUEST

102779/SAO

Original (for SUBMISSION) - printed on 07.06.2000 10:51:51 AM

10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	30 JUNE 2000	(30.06.00)
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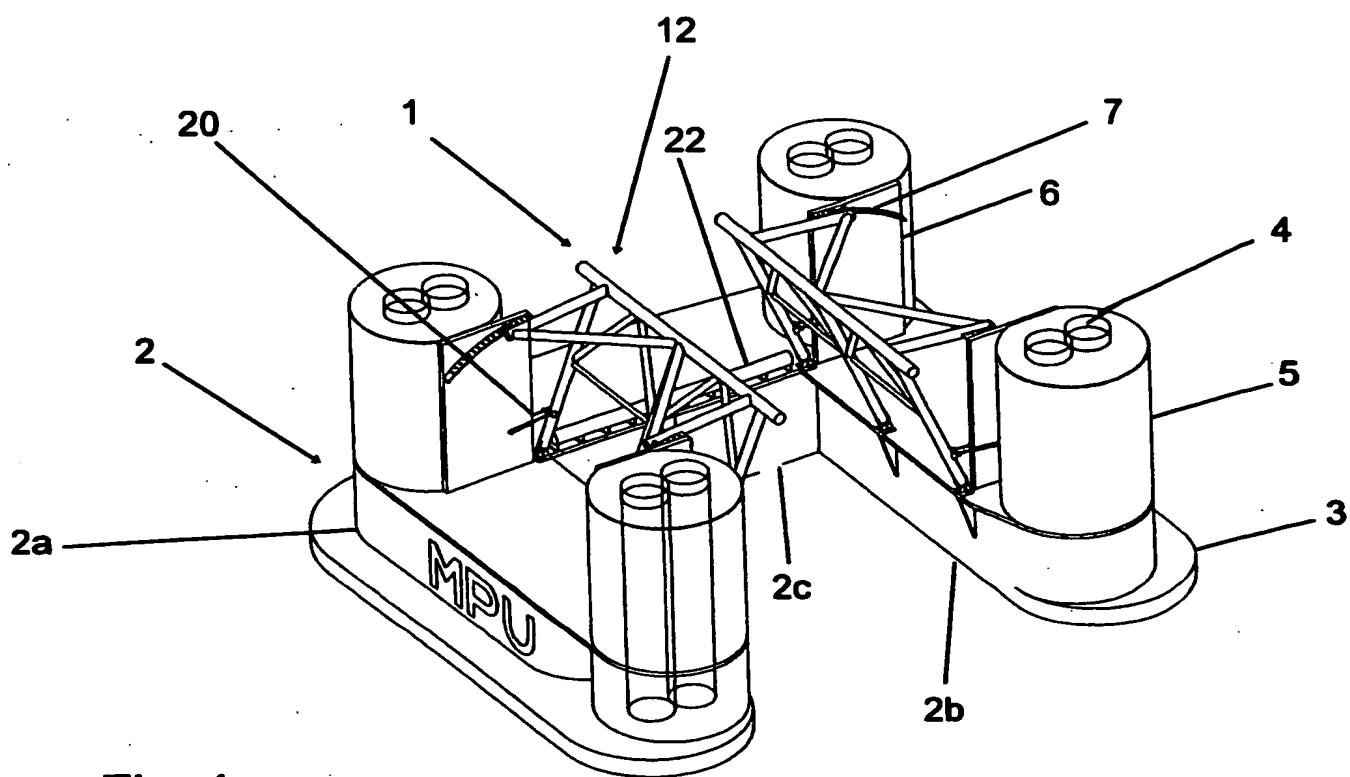


Fig. 1a

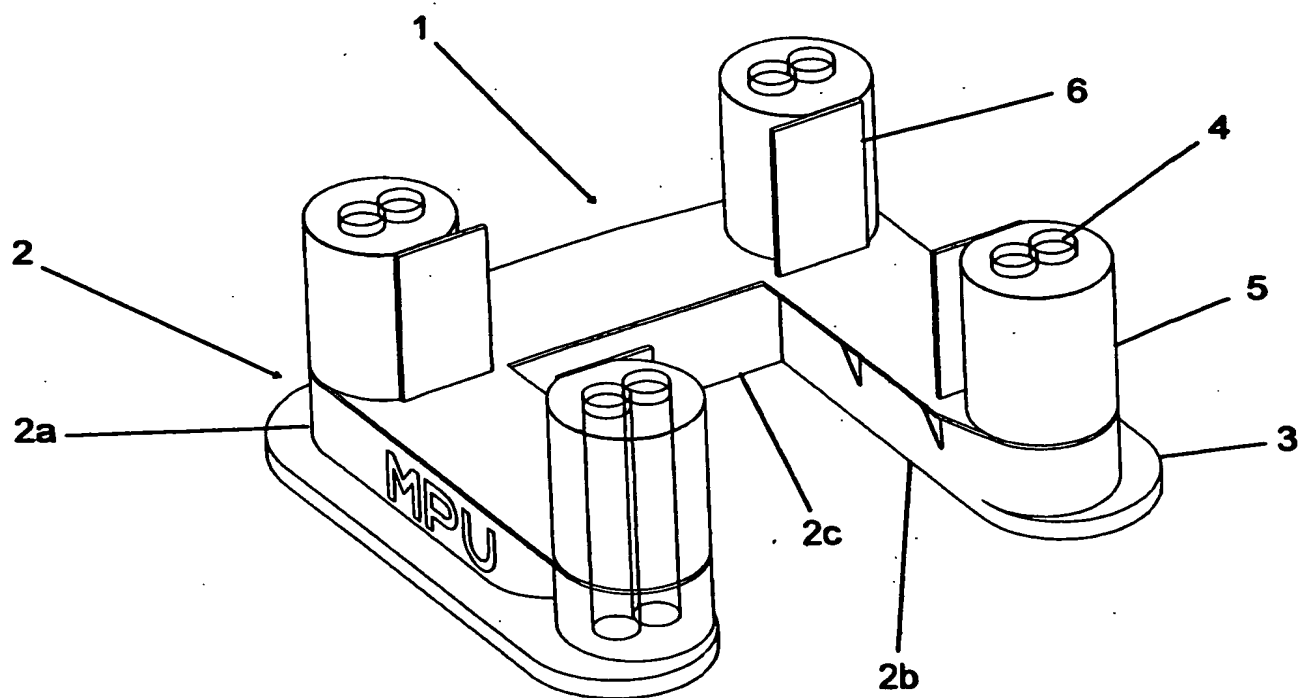


Fig. 1b

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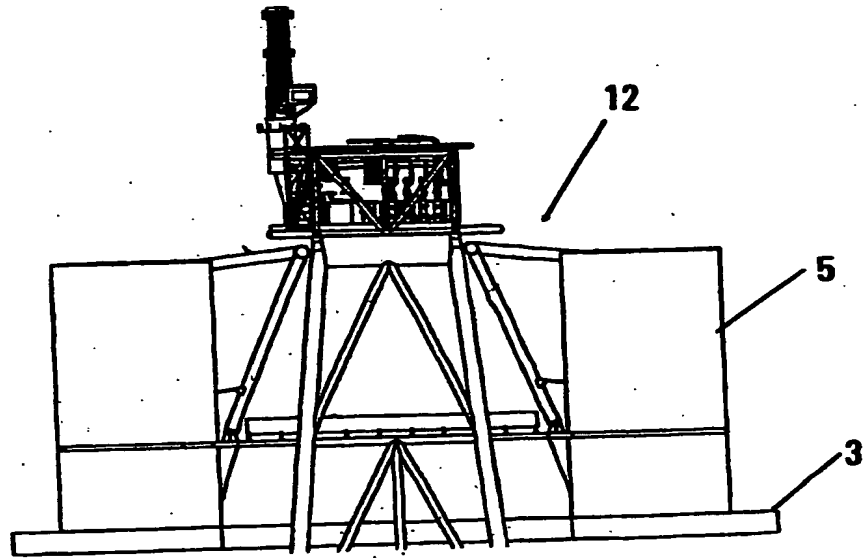


Fig. 2

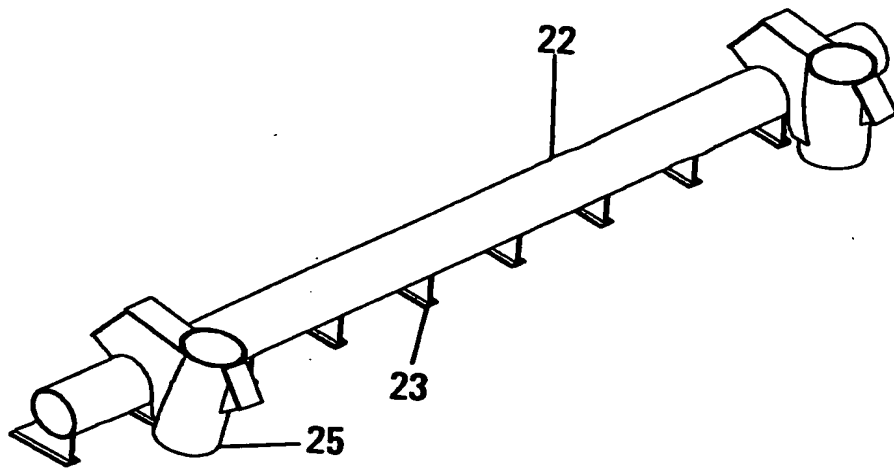


Fig. 3

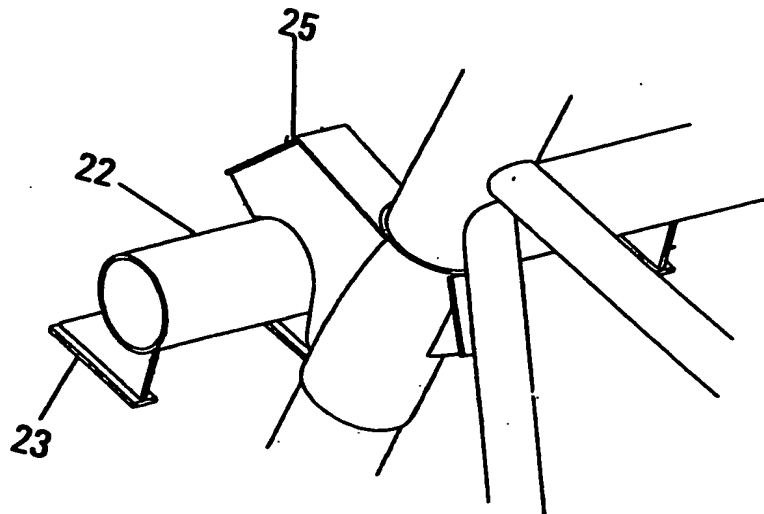
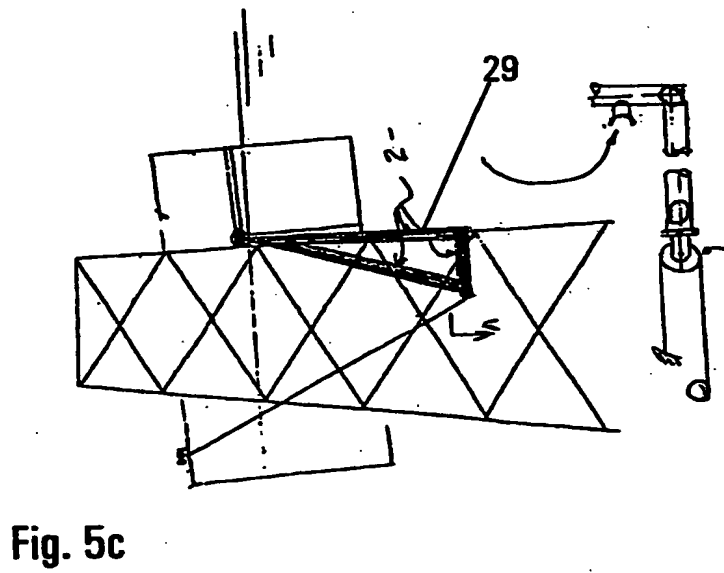
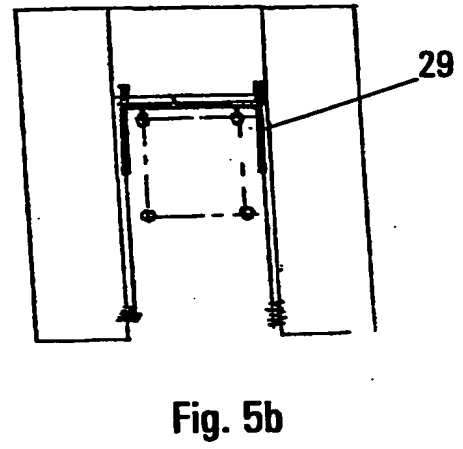
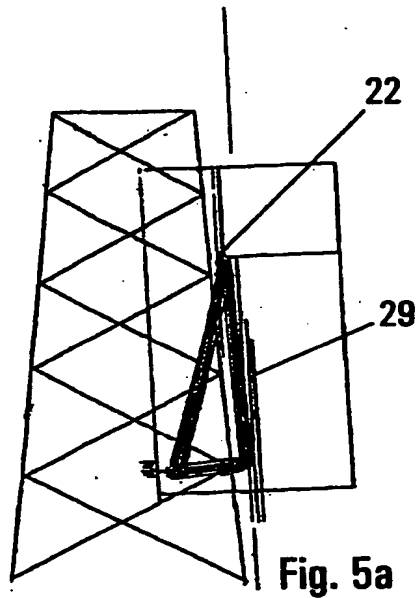


Fig. 4

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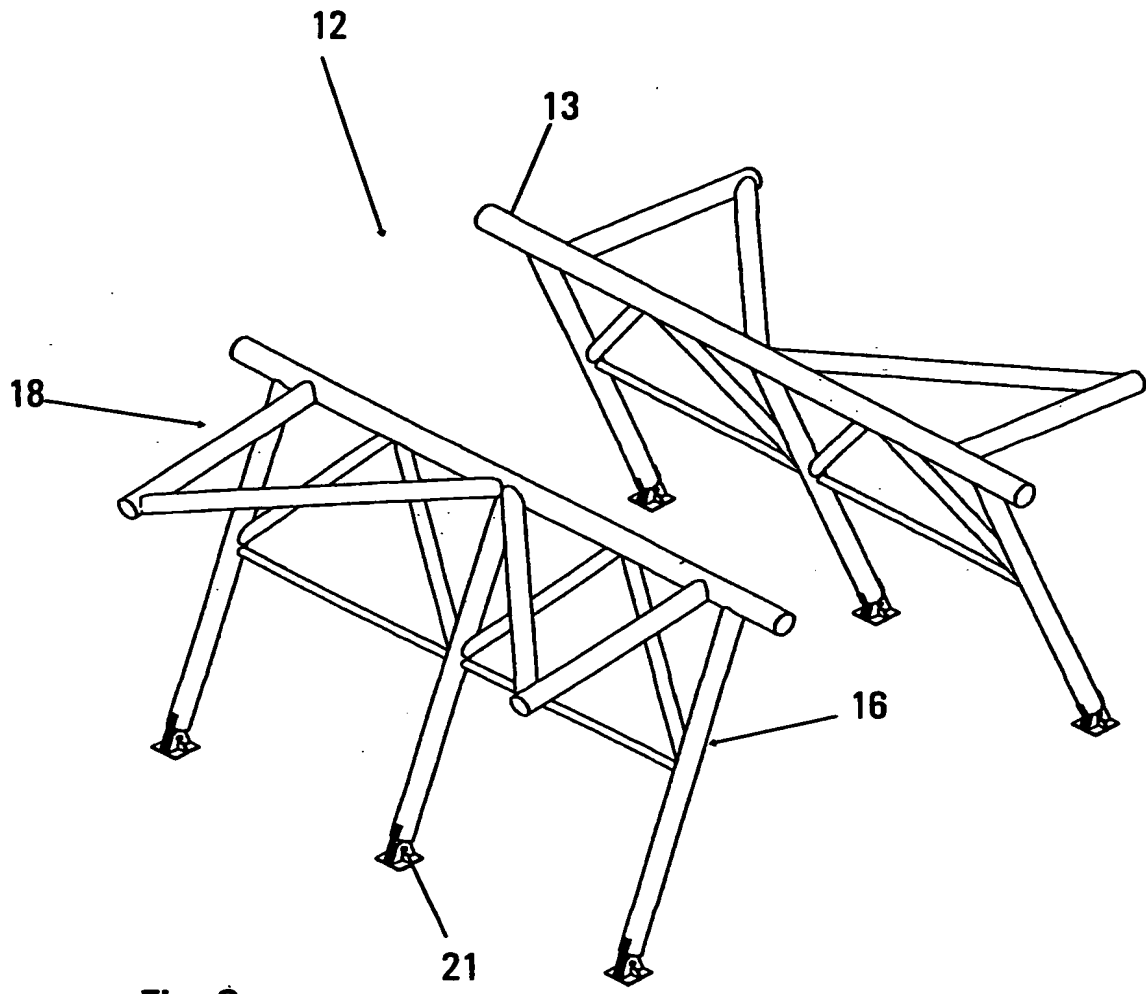


Fig. 6

5/13

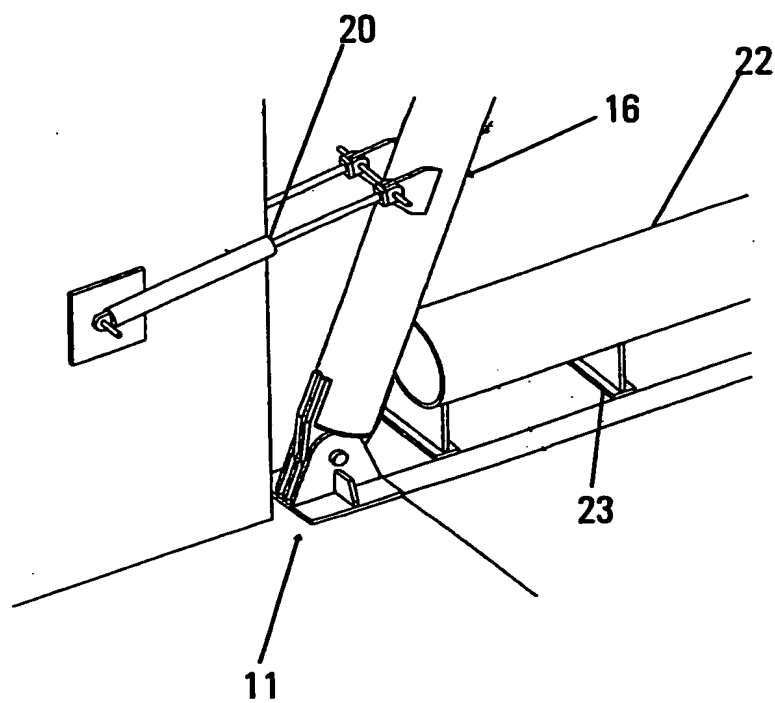


Fig. 7

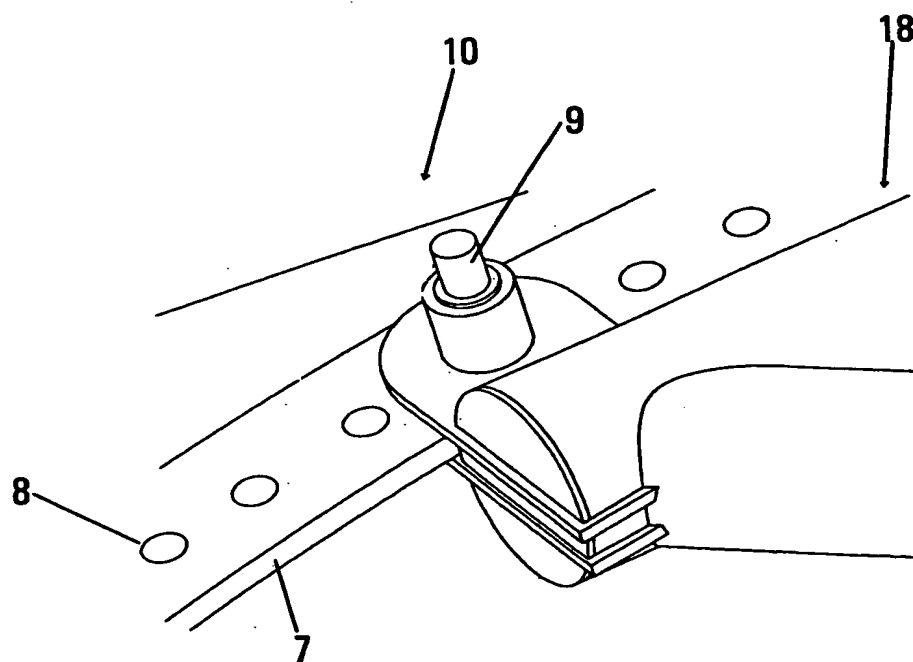


Fig. 8

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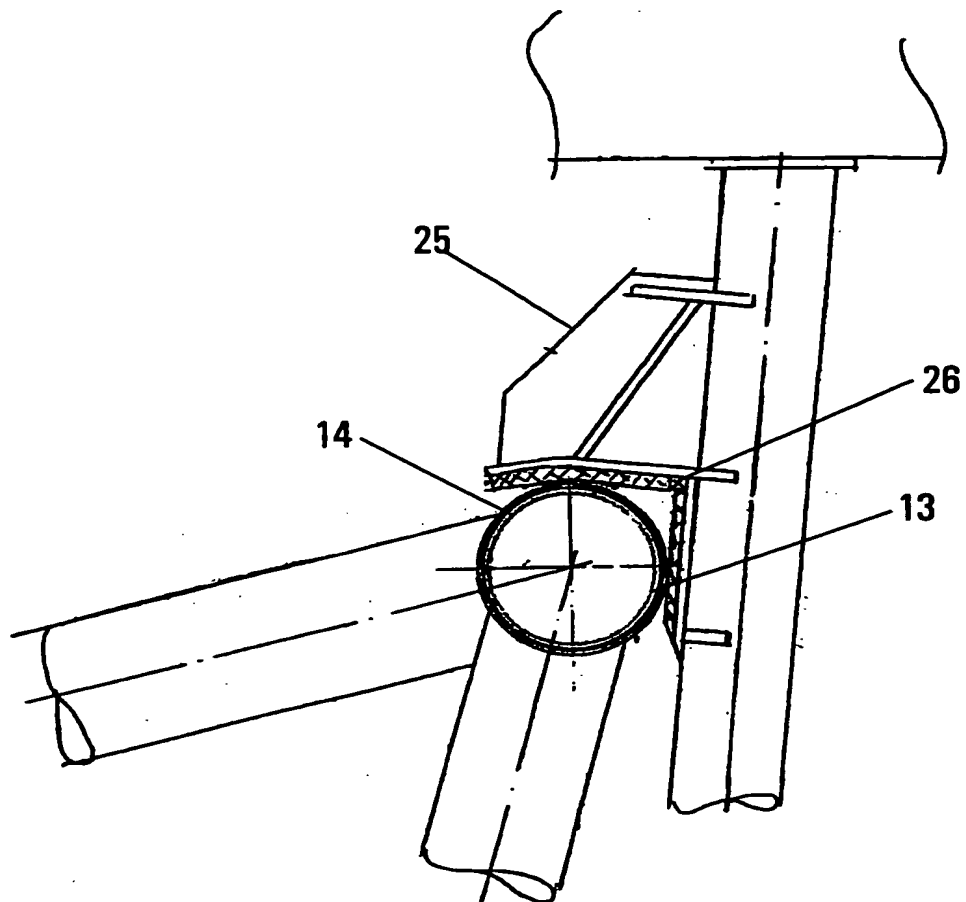


Fig. 9

7/13

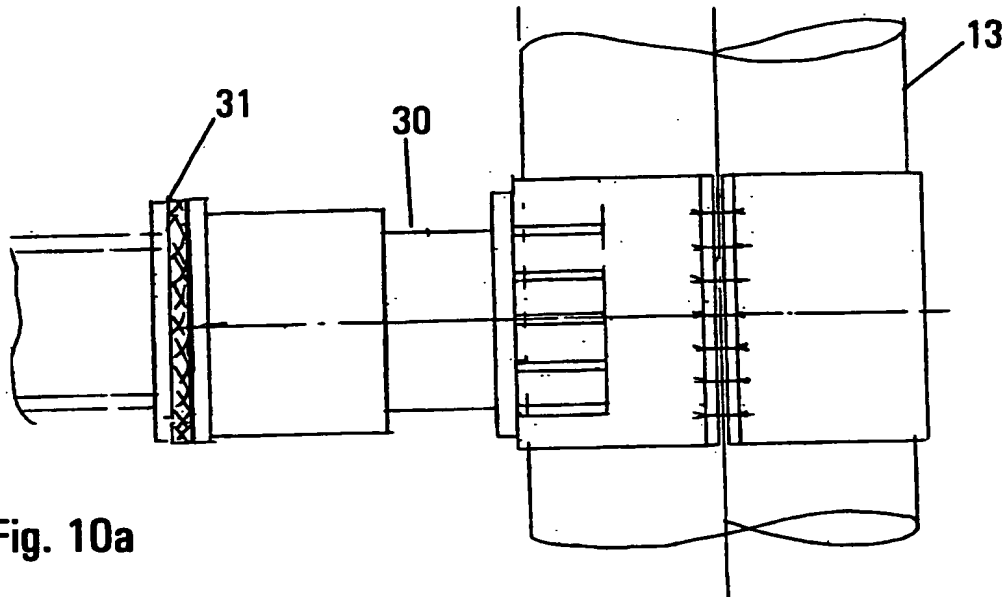


Fig. 10a

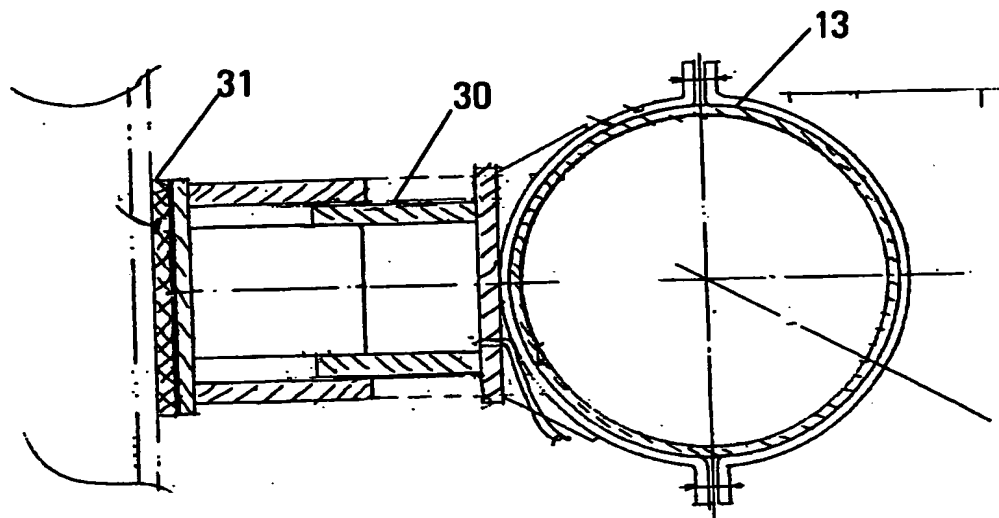


Fig. 10b

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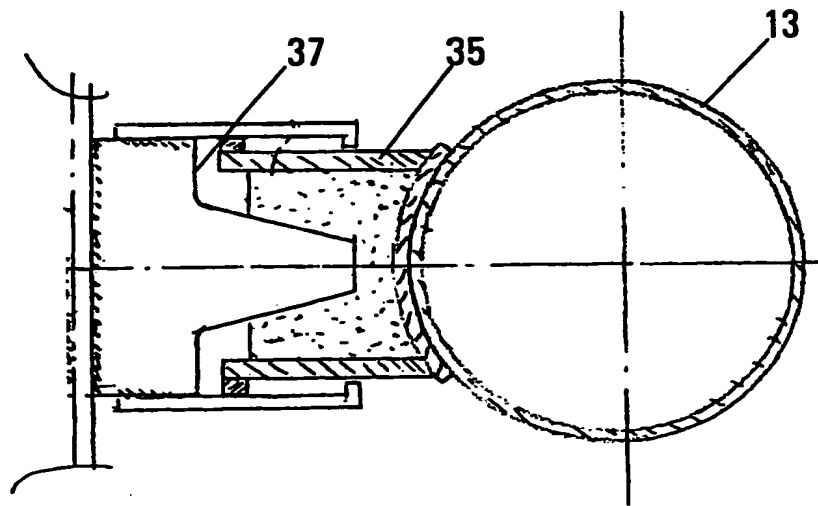


Fig. 11a

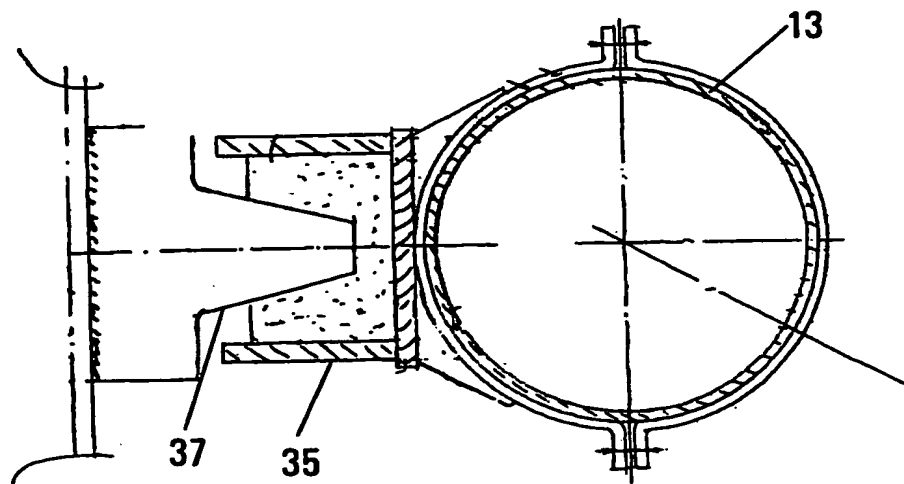
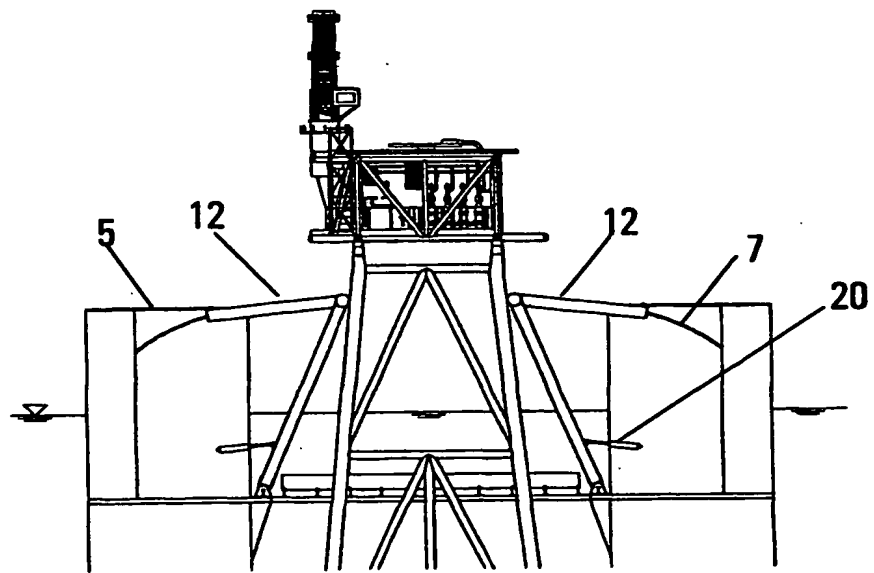
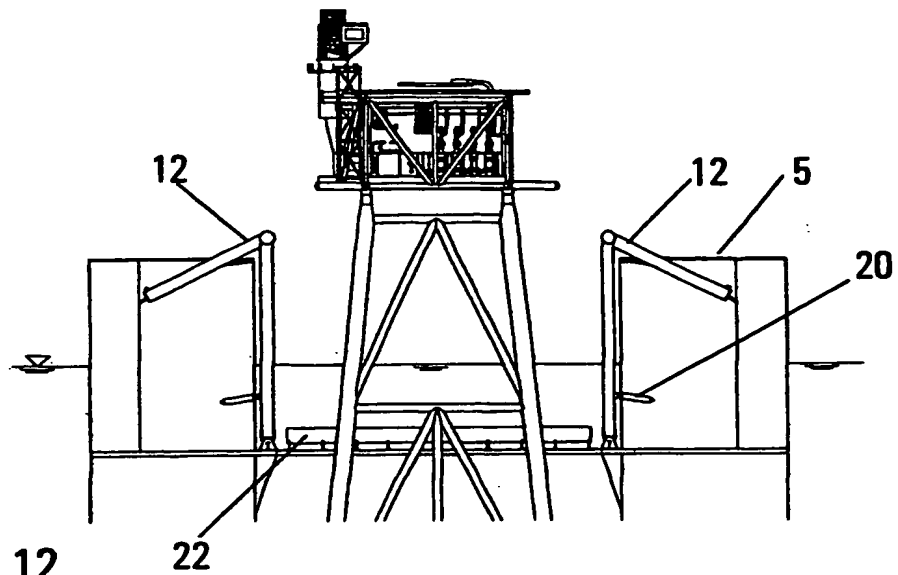


Fig. 11b



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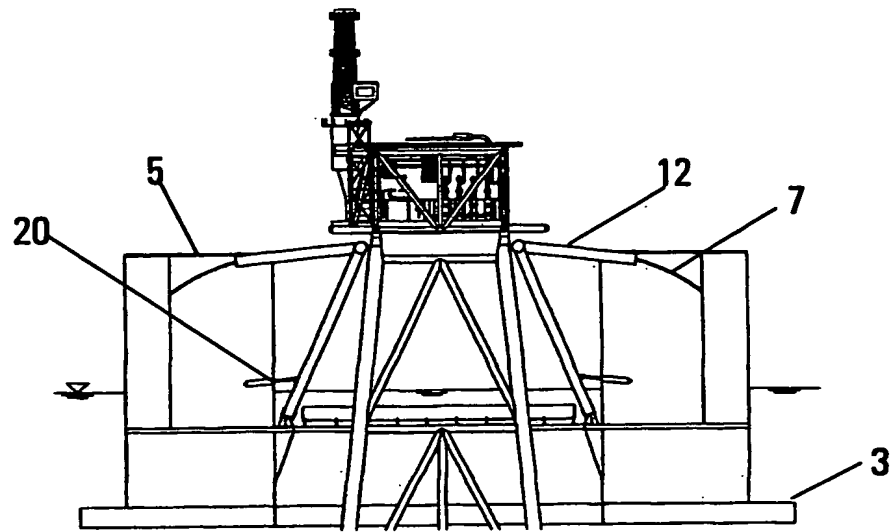


Fig. 14

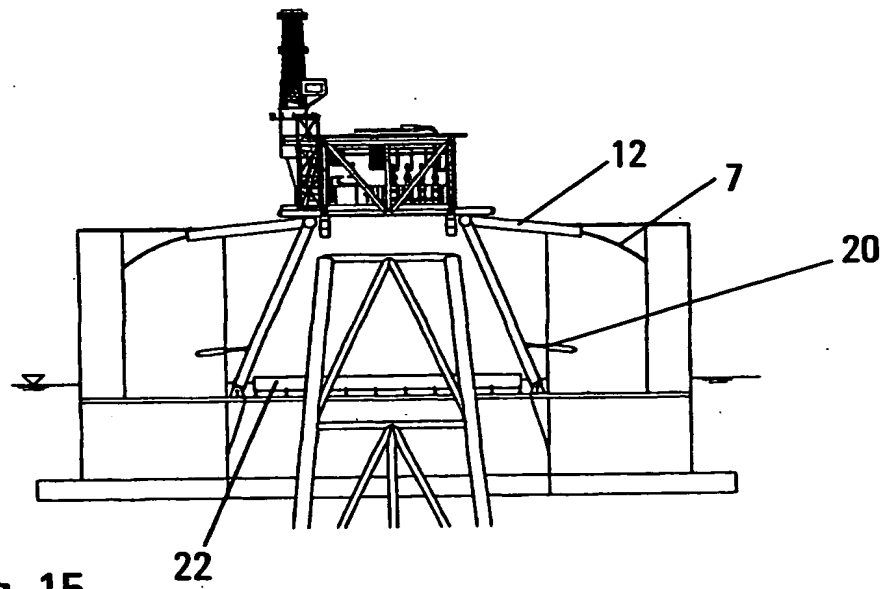


Fig. 15

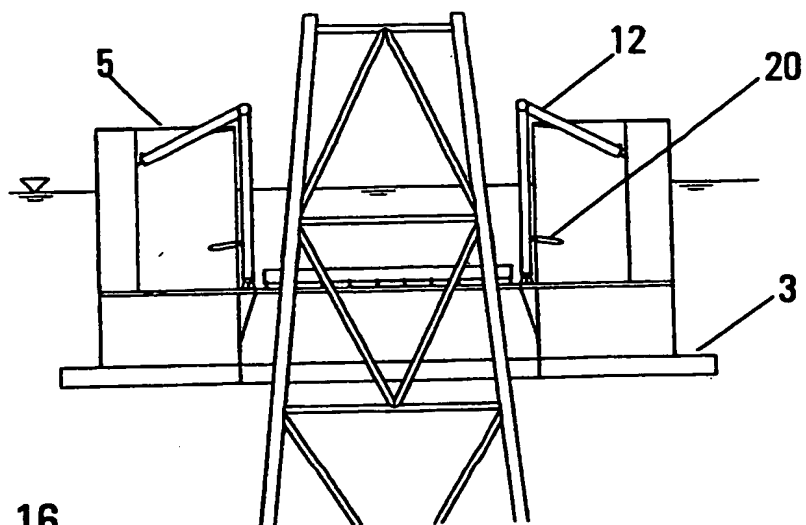


Fig. 16

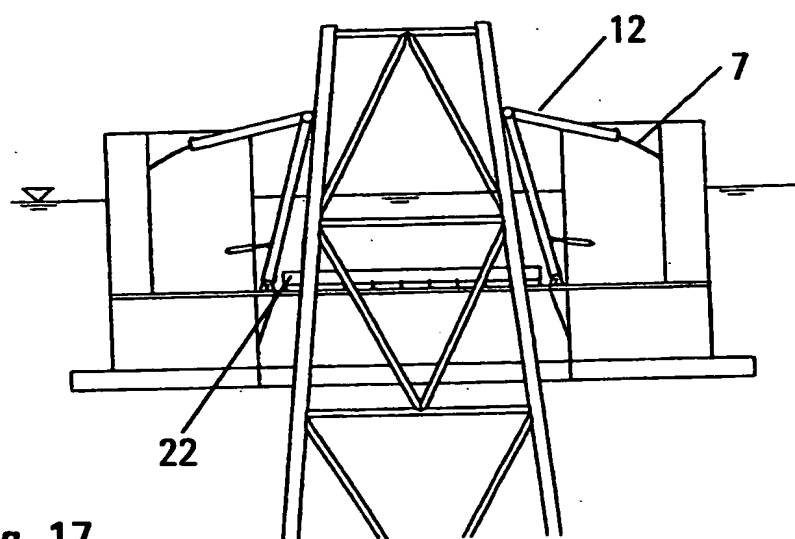


Fig. 17

12/13

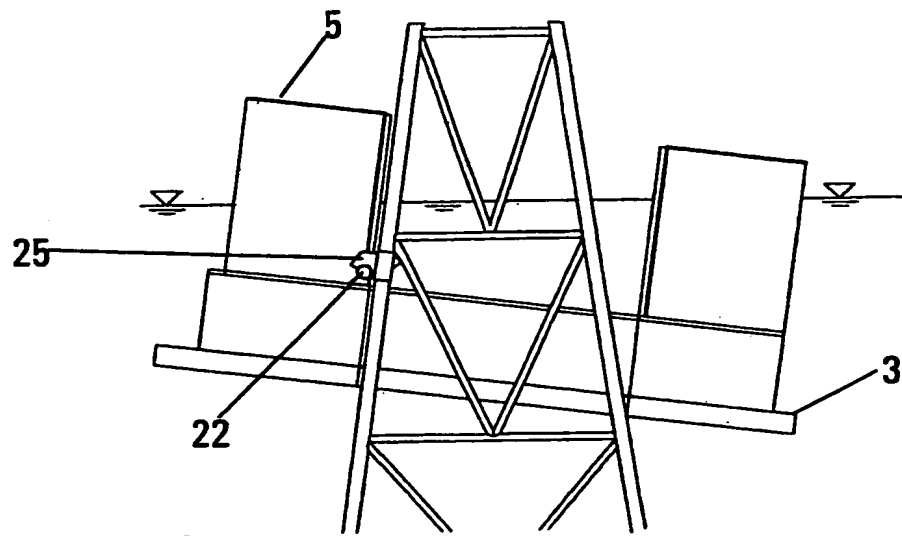


Fig. 18

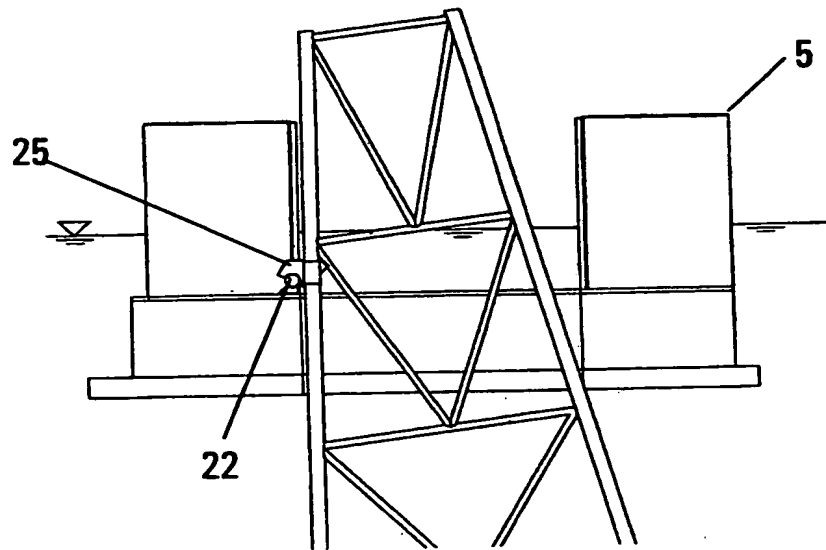


Fig. 19

13/13

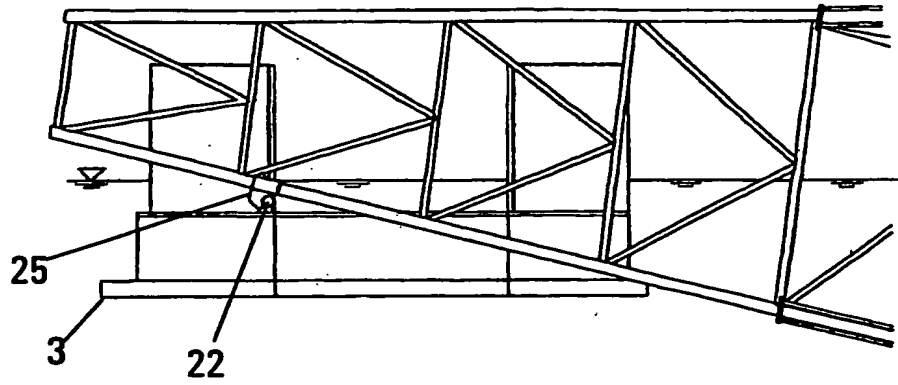


Fig. 20

O.nr. 102779

Anordning for posisjonering og løfting av en marin konstruksjon, særlig et plattformdekk.

Den foreliggende oppfinnelse angår en anordning for posisjonering og løfting av en marin konstruksjon, særlig et plattformdekk, ved hjelp av et løftefartøy.

I forbindelse med offshore-aktiviteter slik som olje- og gassutvinning er det vanlig å installere plattformer på feltet. Disse plattformene består ofte av store og tunge understellskonstruksjoner som er fastgjort i havbunnen. En slikt understellskonstruksjon er vanligvis en såkalt "jacket" som er en fagverkskonstruksjon i stål. På toppen av for eksempel jacketkonstruksjonen er det vanlig å plassere et plattformdekk, som benyttes i forbindelse med boring og produksjon. Dekket innbefatter ofte også et boligkvarter.

For å frakte og installere plattformunderstell og plattformdekk av den ovenfor beskrevne type har det vært benyttet for eksempel lektere som transporterer understellet og plattformdekket ut på feltet og store kranskip har vært benyttet ved installasjon av plattformen på feltet.

Det har også vært benyttet ballasterbare fartøy for å transportere og installere plattformer offshore.

Det er i dag et stort antall av plattformer til havs som er installert for å utvinne olje og gass. Etter som olje- og/eller gassreservoarene på et felt er oppbrukt, vil plattformens levetid ofte være over, og i mange tilfeller vil det derfor være aktuelt å fjerne plattformen.

Noen plattformer er allerede fjernet, og dette vil i økende grad fortsette i de nærmeste årene.

Den tradisjonelle måten å fjerne en plattform på er å benytte store, havgående kranfartøyer. Plattformen må prepareres grundig, og den må blant annet deles opp i biter da selv store løftefartøy har begrenset løftekapasitet. Tilsvarende er tilfelle for plattformunderstellet (jacketen).

Disse operasjoner er tidkrevende og kostbare, både fordi kranfartøyene er store, dyre og krever høy bemanning, og fordi det er komplisert å jobbe offshore med å dele opp en plattform. Dette er heller ikke en risikofri operasjon.

Denne nye teknologi kan betegnes som "single lift technology", og vil gi store besparelser med hensyn til kostnader. Den vil også være mindre risikofylt enn nåværende fremgangsmåter. Innenfor "single lift technology" finnes det tre konsepter som søkeren i dag kjenner til:

Offshore shuttle er et fartøy planlagt bygget opp av en fagverkskonstruksjon. Fartøyet har en vesentlig lengde og løfting av for eksempel et plattformdekk er basert på tverrbjelker som spenner over konstruksjonen på tvers.

Master Marine er i ferd med å utvikle et U-formet, halvt nedsenkbart fartøy (semi) med bærekonstruksjon (dekk) som forbinder søylene i toppen. Løfting er basert på lastoverføring til denne dekkkonstruksjonen.

Versatruss er utviklet et konsept som omfatter separate lektere som understøtter hver sin løfteramme. Ved å trekke lekterne sammen etter å ha posisjonert løfterammene inn under løftepunktet i dekket kan dekket løftes av understellet. Denne fremgangsmåten har allerede blitt brukt til løfting av små plattformdekk i rolig farvann.

Et mål med den foreliggende oppfinnelse er å kunne gjennomføre en fjerningsoperasjon av en plattform på en hurtig og kostnadseffektiv måte uten å måtte dele opp dekket eventuelt understellet i biter. Fjerningsoperasjonen skal også utføres på en trygg måte hvor sikkerheten til operatørene skal ivaretas på best mulig måte.

Et annet mål med den foreliggende oppfinnelse er at løfteutstyret skal være mest mulig fleksibelt, slik at det kan tilpasses forskjellige plattformdekkbredder. Videre skal utstyret kunne benyttes til å løfte og håndtere jacketer av forskjellig størrelse. Anordningen i henhold til oppfinnelsen skal kunne benyttes i forbindelse med et fartøy, en såkalt "flerformålsenhhet" (engelsk Multi Purpose Unit, MPU), som også skal kunne frakte for eksempel plattformdekket til land, for så overføre dekket til en lekter innaskjærs, eventuelt en pir som er tilpasset fartøyet.

Et annet mål med anordningen er at den også skal kunne anvendes til installasjon av plattformer, som i hovedtrekk er det omvendte av fjerning. Videre skal anordningen kunne anvendes ved en rekke andre formål der stor bæreevne er påkrevet.

De ovenfor angitte mål oppnås ifølge oppfinnelsen ved en anordning for posisjonering og løfting av en marin konstruksjon, særlig et plattformdekk, innen et

løftefartøys dokkområde, kjennetegnet ved at den omfatter minst to justerbare understøttelsesrammer som hver kan vinkles innover i løftefartøyets dokkområde, idet hver understøttelsesramme består av en horisontal øvre løftebjelke, som fortrinnsvis er anordnet i et nivå over løftefartøyet, en skråstagkonstruksjon som i sin øvre ende er forbundet med løftebjelken og som i sin nedre ende er leddlagret til løftefartøyet, og en tilnærmet horisontalkonstruksjon som i sin ene ende er forbundet med løftebjelken og som i sin andre ende er justerbart innfestet til løftefartøyet.

Foretrukne utførelsesformer av anordningen er videre utdypet i kravene 2 til og med 9.

Den foreliggende oppfinnelse skal i det følgende forklares ved hjelp av utførelseseksempler og med henvisning til figurene, hvor

Fig. 1a viser et løftefartøy som anvendes i forbindelse med anordningen ifølge foreliggende oppfinnelse,

Fig. 1b viser selve løftefartøyet ifølge foreliggende oppfinnelse,

Fig. 2 viser løftefartøyet plassert rundt en fagverksplattform med plattformdekk,

Fig. 3 viser en rørbjelke for løfting og rotasjon av en fagverksplattform,

Fig. 4 viser en anordning for løfting og rotasjon av fagverkskonstruksjoner ved installasjon eller fjerning,

Fig. 5a-5c viser fartøyet i forbindelse med løfting og håndtering av en fagverksplattform hvor en spesiell "vugge" benyttes,

Fig. 6 viser foreliggende anordning i form av understøttelsesrammer anvendt i forbindelse med løfting av fortrinnsvis et plattformdekk,

Fig. 7 viser hydrauliske armer (jekkesystem) som er anordnet mellom løftefartøyet og understøttelsesrammens skråstagkonstruksjon, og figuren viser også den rørformede bjelken for rotasjon/fjerning av en fagverksplattform,

Fig. 8 viser et hydraulisk boltsystem for låsing av understøttelsesrammen til en glideskinne på løftefartøyet,

Fig. 9 er et første alternativ av en forbindelse mellom understøttelsesrammen og fagverksplattformen for fjerning av et dekk,

Fig. 10a og 10b viser et andre alternativ av en forbindelse mellom understøttelsesrammen og fagverksplattformen for fjerning av et dekk,

Fig. 11a og 11b viser et tredje alternativ av en forbindelse mellom understøttelsesrammen og fagverksplattformen for fjerning av et dekk.

Fig. 12, 13, 14 og 15 viser den trinnvise operasjonen for fjerning av et plattformdekk ved hjelp av løftefartøyet, og

Fig. 16, 17, 18, 19 og 20 viser den trinnvise operasjonen for fjerning av et plattformunderstell ved hjelp av løftefartøyet.

Anordningen ifølge foreliggende oppfinnelse skal nå forklares med henvisning til figurene og først spesielt med henvisning til fig. 1a og 2.

Anordningen ifølge foreliggende oppfinnelse skal nå forklares i forbindelse med et kranfartøy som er beskyttet gjennom norsk patent søknad nr 99 2759 tilhørende søkeren av foreliggende oppfinnelse. Anordningen ifølge foreliggende oppfinnelse er derfor beskrevet i forbindelse med dette kranfartøyet, men det skal imidlertid forstås at anordningen kan brukes i forbindelse med andre fartøy og annet utstyr.

Løftefartøyet 1 (MPU'en) er utviklet som et flytende betongskrog med et U-formet pongtongfundament 2 bestående av to langsgående pongtonger 2a, 2b samt en tverrpongtong 2c, og med søyler 5 gjennom vannlinjen for hydrostatisk stabilitet og optimal oppførsel i sjøen. Søylene 5 er ikke strukturelt forbundet i toppen, noe som muliggjøres av en stiv og robust skrogkonstruksjon. En brem 3 langs nedre kant av pongtongen forbedrer ytterligere fartøyet oppførsel i sjøen. Fartøyet 1 er spesielt utviklet for operasjon til havs. Den U-formede pongtongen 2a, 2b, 2c gjør at fartøyet 1 kan posisjoneres inn rundt en plattform for installasjon eller løft av plattformdekk eventuelt løft av bærestrukturen. Løfting foregår etter Arkimedes' prinsipp ved ballastering/deballastering av fartøyet 1. Løfting foregår i hovedsak vertikalt, men fartøyet 1 kan også skråstilles/tiltes noe for å tilpasses spesielle løfteoperasjoner.

Posisjonering av fartøyet 1 er i første rekke tenkt utført ved hjelp av slepebåter, men installasjon av egne trustere er også mulig for at fartøyet skal kunne bli "selvgående". Fartøyet 1 er konstruert for å kunne utføre operasjoner i alle havområder i verden. For å lette frakt fra et havområde til et annet er fartøyet konstruert for frakt på tungløftskip.

Fartøyet 1 er utrustet med anordninger som er tilpasset de operasjoner som fartøyet er tiltenkt å utføre. Som eksempel på operasjoner kan nevnes installasjon og fjerning av plattformer (understell og dekk) for olje og gassindustrien.

Installasjon og fjerning av plattformunderstell er som nevnt ovenfor et aktuelt operasjonsområde for fartøyet. Fartøyet 1 skal nå først forklares i forbindelse med denne type operasjon, og nærmere bestemt i forbindelse med håndtering av fagverksplattformer (engelsk jackets). Fagverksplattformer av stål brukes i olje og gassindustrien over hele verden som understell for produksjon av olje og gass til havs. Man kan også tenke seg andre sammenhenger der en jacket-konstruksjon kan være hensiktsmessig å bruke som en bærestruktur. Det vil i fremtiden være et marked for både installasjon og fjerning av jacketkonstruksjoner. Nedenfor er det beskrevet operasjoner vedrørende fjerning av en jacket. For installasjon gjøres operasjonene i omvendt rekkefølge.

Løftebraketter 25 festes til jacketbenene langs en side av jacketen, i forhåndsbestemt høyde. På løftefartøyet er en rørbjelke 22 fastmontert på toppen av tverrpongtingen 2c. Løftefartøyet 1 posisjoneres rundt jacketkonstruksjonen ved hjelp av slepebåter samt aktiv bruk av en anordning ifølge foreliggende oppfinnelse som er i form av en understøttelsesramme (løfteramme) 12 og denne vil beskrives mer utførlig nedenfor i forbindelse med løfteinnretninger for posisjonering og løfting av et plattformdekk. Fartøyet 1 bukseres inntil dets tverrpongting 2c ligger an mot plattformunderstellets ene side der hvor løftebraketter 25 er montert. Løftefartøyet ballasteres til riktig elevasjon og helningsvinkel slik at rørbjelken 22 tar tak under løftebrakettene 25, se fig. 4, samtidig som underkant av tverrpongtingen 2c ligger an mot jacketbenene med fenderne i mellom. Løftebrakettene 25 låses til rørbjelken 22 og jacketen løftes ved hjelp av ballastering av fartøyet 1. Etter at jacketen er løftet klar av bunnen (eventuelt fundamentet) vippes bunnpartiet av jacketkonstruksjonen opp til overflatenivået ved å rotere om rørbjelken 22, ved hjelp av vaiere fra vinsjer (eventuelt ved bruk av ballastering/oppdriftslegemer), før transport til ny destinasjon.

Løftebrakettene 25 er av stål i kraftig utførelse og vil ta opp alle krefter tilført av et løft/rotasjon. Løftebrakettene er konstruert slik at jacketkonstruksjonen vil bli hindret i å bevege seg av brakettene. Løftebrakettene 25 kan enkelt rotere på rørbjelken 22.

En forprosjektering er nødvendig før et løft kan foretas med hensyn til styrken i jacketkonstruksjonen. Hvis ikke benene tåler belastningen de vil utsettes for, må de forsterkes. Løftebrakettene 25 kan om nødvendig utformes med to lengere rørklemmer og en skive mellom dem, slik at de kan monteres på hovedbenet og en diagonalavstiver. Brakettene tar opp krefter fra rørbjelken 22 og fordeler dem til rørklemmene som igjen vil fordele kraften i aksial retning av benet og avstiveren slik at de største skjærkreftene unngås. Denne anordningen må dimensjoneres for hvert enkelt tilfelle.

For enkelte jacketkonstruksjoner kan det være vanskelig å dimensjonere innfestingen av løftebrakettene 25 og en "løftevugge" kan tas i bruk, se fig. 5. Løftevuggen festes i rørbjelken 22 og bruker denne som rotasjonspunkt som beskrevet over. Vuggen 29 er et rammeverk bestående av to triangulære rammer pekende utover med en spissende opp og forbundet med en rørbjelke nederst i perpendikulæren og gjennom rørbjelken opp på tverrbjelken. Vuggen 29 er satt sammen av rør med to – tre meter i diameter og vil fylles med vann i henteposisjonen og det deballasteres når løftet starter. De store dimensjonene er for styrke og for å oppnå nok oppdrift til at det hjelper på løftet.

Løftefartøyet 1 posisjoneres som beskrevet ovenfor og løftevuggen 29 vil omfavne jacketen. På rørbjelken i bunnen av løftevuggen festes det spesielt tilpassede sadelanlegg hvor jacketbenene hviler inntil. Festekroker festes til jacketbenene i høyde med øverste rørbjelke 22 og hektes på rørbjelken for at konstruksjonen ikke sklir av når løftet foretas. Bakerst på løftefartøyet 1 er det montert vinsjer på hver side av "dokkområdet" d.v.s. det indre området av den U-formede pongtongen som er innesluttet av de to langsgående pongtongene 2a, 2b og den tverrgående pongtongen 2c. Vinsjer på slepebåter kan eventuelt anvendes. Via taljer blir vaiere med krok i enden festet til korthjørnene på løftevuggen 29. Vuggen løftes opp og roterer om øvre rørbjelke 22 og jacketkonstruksjonen blir løftet opp av vannet og kan fraktes trykt til land. En alternativ fremgangsmåte er ballastering av løftefartøyet 1 kombinert med oppdriftslegemer på jacketen.

Foreliggende anordning for posisjonering og løft av plattformdekk skal nå forklares med henvisning til tegningene. Plattformdekk finnes i mange forskjellige størrelser og for å kunne være i stand til å løfte alle typer må løfteinnretningene

være store, sterke og fleksible eventuelt justerbare, det stilles krav til utformingen for å komme i posisjon rundt bærekonstruksjonen som bærer dekket.

Understøttelsesramme 12 ifølge en utførelse av oppfinnelsen er anordnet med en kraftig løftebjelke (horisontal løftebjelke) 13 i toppen er leddlagret 21 på hver side av dokkområdet langsetter på nivå med toppen av langsgående pongtonger 2a, 2b, se fig. 1. Understøttelsesrammen 12 består av en horisontalkonstruksjon 18, fortrinnsvis et rammeverk, som strekker seg fra den horisontale løftebjelken 13 til en øvre innfesting 10 på løftefartøyet 1. Videre består understøttelsesrammen 12 av en skråstagkonstruksjon 16, som fortrinnsvis er i form av en fagverkskonstruksjon, og som videre er forbundet med den horisontale løftebjelken 13 i den øvre enden og med løftefartøyet i den nedre enden via en nedre innfesting 11, fortrinnsvis i form av et leddlager 21. Understøttelsesrammene 12, 12 strekker seg til over toppen av løftefartøyet 1, slik at løftebjelkene 13, 13 alltid er høyere enn skroget til løftefartøyet 1. Understøttelsesrammene 12, 12 kan vinkles innover i dokkområdet, slik at løftebjelkene 13, 13 kan posisjoneres (kjøres ut og inn) under løftepunkter på plattformdekket ved hjelp av hydrauliske armer 20, 20 fra hver ende av rammen og tilbake til løftefartøyets skrog 1, se fig. 1a og 7. De to understøttelsesrammene 12, 12 kan kjøres uavhengig av hverandre. Understøttelsesrammene 12, 12 er låst fast i riktig posisjon før løftet utføres, ved hjelp av bolter 9 som settes inn i hull 8 i en glideskinne 7, i toppen av hver av de fire søylene 5 i løftefartøyets skrog, se fig. 1a og 7. Dette sikrer fastholding i alle retninger inkludert "sea fastening" for transport. For innfesting av glideskinnen 7 er det anordnet en plan utvendig vegg 6 som er tangentielt innrettet på søylene 5. Den plane vegg 6 er videre anordnet perpendikulært på forbindelseslinjen mellom to søyler 5, 5.

Selve koplingen mellom den horisontale løftebjelke 13 og dekk kan utføres på forskjellige måter. Nedenfor er det beskrevet tre måter som sørger for at tilstrekkelig mykhet oppnås for å dempe støt ved avløft:

i) løftebjelken 13 belegges med støtabsorberende belegg 14 samtidig som støtabsorberende puter plasseres på undersiden av dekket. Hvis ikke dekket er konstruert slik at man kan ta tak direkte under dekksrammen kan man montere braketter 26 med støtputer på øvre del av jacket-strukturen, slik at løftebjelken 13 kan ta tak i disse (se fig. 9). Før avløft kuttet så jacketen under disse brakettene.

ii) Hydrauliske sylindre 30 plasseres på løftebjelken 13 i forhåndsbestemte posisjoner for direkte kontakt med løftepunkter i dekkstrukturen (eventuelt braketter på øvre del av jacket). Støtputer 31 plasseres mellom dekkstruktur og hydrauliske sylindre 30 for maksimal demping (se fig. 10).

iii) "Sjokk-celler", bestående av sandfylte sylindre 35 eller annet materiale som kan ta opp støt, plasseres på toppen av løftebjelker 13 i forhåndsbestemte posisjoner. Konede rørstubber 37 festes til dekkstrukturen i posisjoner som tilsvarer posisjoner av "sjokk-celler". Støt dempes ved at disse konede rørstubbene 37 trenger seg ned i de sandfylte cellene (se fig. 11a). Et alternativ er at både rørstubber 37 og de sandfylte sylindrene 35 henger på plattformdekket (se fig. 11b).

MPU'en 1 blir posisjonert rundt en jacket-konstruksjon med dekk og det blir gjort klart for løft og fjerning av dekket. Understøttelsesrammene 12, 12 på hver side av "dokkområdet" brukes aktivt i posisjoneringen ved at de legges mot jacketstrukturen ved hjelp av hydraulikk d.v.s. hydrauliske armer 20 (se fig. 2). I tillegg foregår posisjonering ved hjelp av slepebåter. Når MPU'en 1 er i riktig posisjon trekkes understøttelsesrammene 12, 12 tilbake til riktig posisjon for avløft av dekket og utføres som beskrevet over. Deretter deballasteres MPU'en 1 langsomt inntil løftebjelkene 13 berører oppunder løftepunktene. Kompensering for MPU'ens vertikale bevegelser foregår delvis ved fleksible "støtputer" montert på løftebjelkene og i løftepunktene, og delvis ved bruk av et "flushing-system" som sikrer hurtig lastoverføring fra dekket. Etter at dekket er løftet til sikker klaring over jacketen trekkes MPU'en 1 tilbake og vekk fra jacket-strukturen, og deretter ballasteres MPU'en til "transport-dypgang".

Flushingsystemet består av ballast- (flushing-) tanker 4 over vannlinjen, der vann kan "flushes" ut gjennom hurtigåpnende luker med stort areal. Luker i ulike nivåer sørger for mulighet for "flerfase-flushing", D.v.s. flushing i flere omganger.

Dette eksemplet beskriver operasjonene vedrørende fjerning av et plattformdekk. De forskjellige operasjonene er illustrert i en sekvens av figurer; fig. 12-15.

i. Posisjonering rundt jacket (med dekk)

MPU'en 1 posisjoneres rundt jacketstrukturen ved hjelp av slepebåter. Understøttelsesrammene 12, 12 står i vertikalstilling med god klaring til jacket. Fartøyet 1 dypgang gir god klaring til dekket (ref. fig. 12).

ii. Fin-posisjonering rundt jacket ved hjelp av understøttelsesrammer 12, 12

Når MPU'en 1 er kommet i tilnærmet riktig posisjon vippes understøttelsesrammene 12, 12 inn mot jacketstrukturen for demping av horisontalbevegelse samt fin-posisjonering. Dette oppnås ved aktiv bruk av hydraulikk (ref. fig. 13).

iii. Deballastering av MPU, klar til avløft

MPU'en deballasteres mens understøttelsesrammene 12, 12 følger langs jacketstrukturen for demping av horisontale bevegelser. Deballastering pågår inntil understøttelsesrammen 12, 12 kommer helt oppunder løftepunktene i dekket. Deretter låses rammene i riktig posisjon og MPU'en er klar for avløft av plattform-dekket (ref. fig. 14).

iv. Avløft av dekket

Når MPU'en er klar til avløft av dekket slippes vann hurtig ut av hurtig-åpnende luker i søylene 5 for hurtig avløft. Dekket er på forhånd klargjort for fjerning ved at all kopling til jacketen er kuttet (ref. fig. 15).

v. Klar for transport til land

Etter avløft trekkes MPU'en 1 vekk fra den gjenstående jacketen. Når MPU'en er klar av jacketen ballasteres den til transportdypgang. Eventuell ytterligere "sea-fastening" utover låsingene av understøttelsesrammene 12, 12 vil bli gjort ved behov og transporten til land kan starte. Det er også mulig å overføre dekket til en lekter før transport til land, slik at MPU'en er tilgjengelig for nye operasjoner umiddelbart (for eksempel fjerning av jacket).

Dette eksemplet beskriver operasjonene rundt fjerning av en jacketstruktur. De forskjellige operasjonene er illustrert i en sekvens av figurer; fig. 16-20.

vi. Posisjonering rundt jacketen (uten dekk)

MPU'en 1 posisjoneres rundt jacketstrukturen ved hjelp av slepebåter. Understøttelsesrammene 12, 12 står i vertikalstilling med god klaring til jacket (ref. fig. 16).

vii. Fin-posisjonering rundt jacket ved hjelp av understøttelsesrammer 12, 12

Når MPU'en er kommet i tilnærmet riktig posisjon vippes understøttelsesrammene 12, 12 inn mot jacketstrukturen for demping av bevegelse samt fin-posisjonering. Dette oppnås ved aktiv bruk av hydraulikk (ref. fig. 17).

viii. MPU tiltet og deballastert, klar til avløft

MPU'en tiltes og deballasteres slik at rørbjelken 22 som er montert på toppen av tverrpongtingen 2c griper fatt i braketter 25 som er forhåndsinstallert på jacket (ref. fig. 18).

ix. Avløft av jacket

Når MPU'en 1 er klar til avløft av jacketen slippes vann hurtig ut av hurtig-åpnende luker i søylene for hurtig avløft. Jacketen er på forhånd klargjort for fjerning ved at peler, førerør o.s.v. er kuttet (ref. fig. 19).

x. Tilting av jacket, klar for transport

Etter avløft roteres jacketen til liggende posisjon ved hjelp av vaier og vinsjer montert bak på MPU'en 1 eventuelt på slepebåter (ref. fig. 20). Det er også mulig å bruke oppdriftselementer montert på jacketen. Deretter foretas "sea-fastening" og transporten til land kan starte. Det er også mulig å overføre jacketen til en lekter før transport til land, slik at MPU'en er tilgjengelig for nye operasjoner umiddelbart.

PATENTKRAV

1. Anordning for posisjonering og løfting av en marin konstruksjon, særlig et plattformdekk, ved hjelp av et U-formet ballasterbart løftefartøy (1),
karakterisert ved at den omfatter minst to justerbare understøttelsesrammer (12, 12) som hver kan vinkles innover i fartøyets dokkområde, idet hver understøttelsesramme (12) består av en horisontal øvre løftebjelke (13), som fortrinnsvis er anordnet i et nivå over løftefartøyet (1), en skråstagkonstruksjon (16) som i sin øvre ende er forbundet med løftebjelken (13) og som i sin nedre ende er leddlagret (21) til løftefartøyet (1), og en tilnærmet horisontalkonstruksjon (18) som i sin ene ende er forbundet med løftebjelken (13) og som i sin andre ende er justerbart innfestet til løftefartøyet (1).
2. Anordning ifølge krav 1,
karakterisert ved at den horisontale øvre løftebjelke (13) er belagt med et utvendig støtabsorberende belegg (14).
3. Anordning ifølge krav 2,
karakterisert ved at det støtabsorberende belegg (14) er gummi.
4. Anordning ifølge krav 1,
karakterisert ved at løftebjelken (13) er anordnet med hydrauliske sylindere (30) i forhåndsbestemte løftekontakt-posisjoner.
5. Anordning ifølge krav 1,
karakterisert ved at løftebjelken (13) er anordnet med sandfylte sylindere (35) i forhåndsbestemte løftekontakt-posisjoner idet de sandfylte sylindere (35) samarbeider med tilhørende konede rørstubber (37) på plattformdekket.
6. Anordning ifølge ethvert av de foregående krav,
karakterisert ved at skråstagkonstruksjonen (16) er en fagverkskonstruksjon.

7. Anordning ifølge ethvert av de foregående krav, karakterisert ved at den tilnærmede horisontalstagkonstruksjonen (18) er en fagverkskonstruksjon.

8. Anordning ifølge ethvert av de foregående krav, karakterisert ved at horisontalkonstruksjonens (18) justerbare innfester til løftefartøyet (1) er i form av en hydraulisk drevet bolt (9) innført i et samarbeidende hull (8) i en glideskinne (7) på løftefartøyet (1).

9. Anordning ifølge ethvert av de foregående krav, karakterisert ved at skråstagkonstruksjonen (16) i et område over leddforbindelsen (21) er anordnet med justerbare, hydrauliske armer (20) forbundet med løftefartøyet (1).

SAMMENDRAG

Anordning for posisjonering og løfting av en marin konstruksjon, særlig et plattformdekk, ved hjelp av et løftefartøy. Anordningen omfatter minst to justerbare understøttelsesrammer (12, 12) som hver kan vinkles innover i dokkområdet, idet hver understøttelsesramme (12) består av en horisontal øvre løftebjelke (13), som fortrinnsvis er anordnet i et nivå over løftefartøyet (1), en skråstagkonstruksjon (16) som i sin øvre ende er forbundet med løftebjelken (13) og som i sin nedre ende er leddlagret (21) til løftefartøyet (1), og en horisontalkonstruksjon (18) som i sin ene ende er forbundet med løftebjelken (13) og som i sin andre ende er justerbart innfestet til løftefartøyet (1).

(Fig. 1a).